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OCTOBER 1956

THE SCIENCE TEACHER

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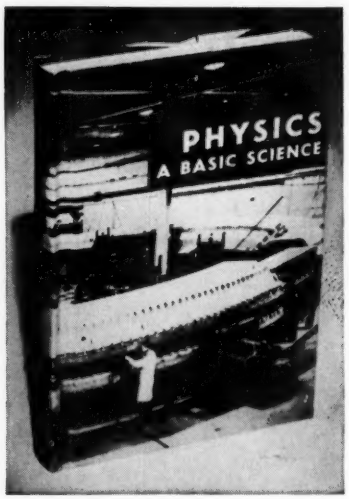

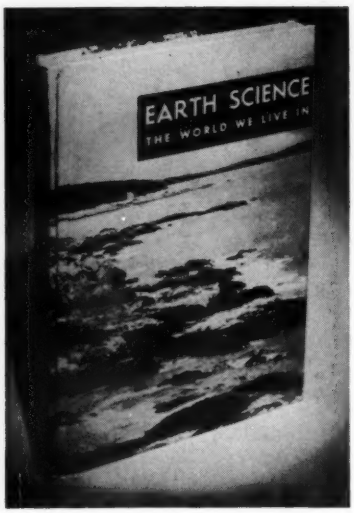

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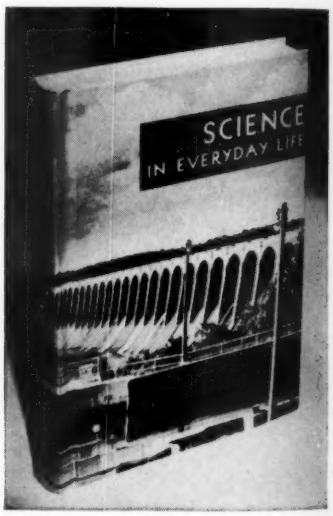

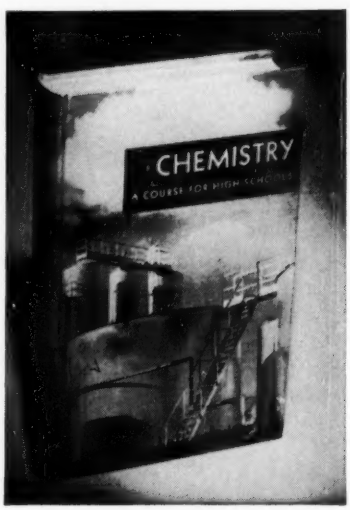

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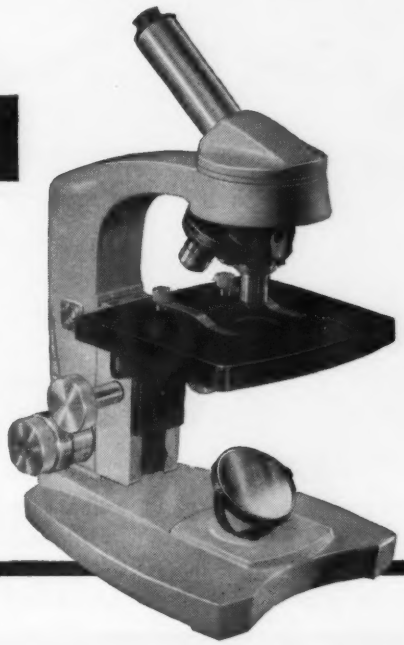

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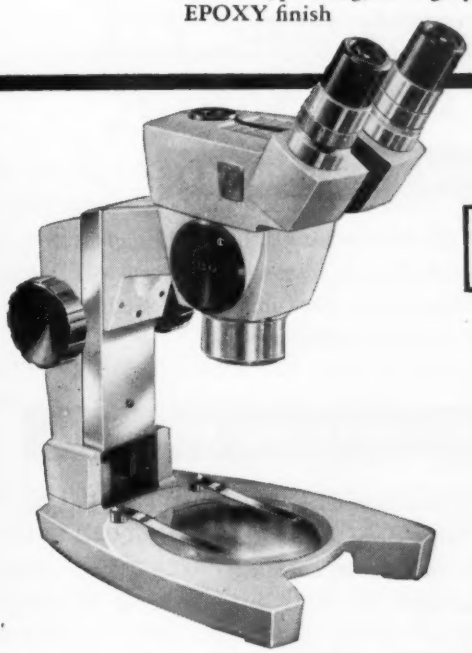

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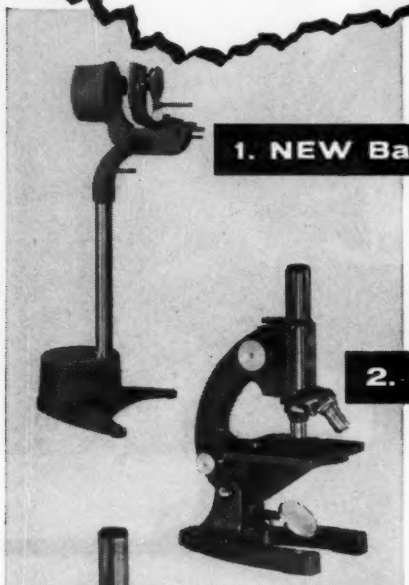

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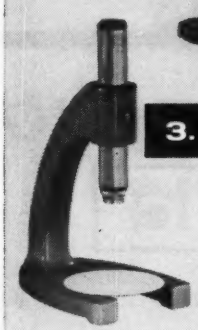

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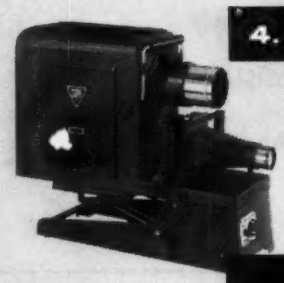

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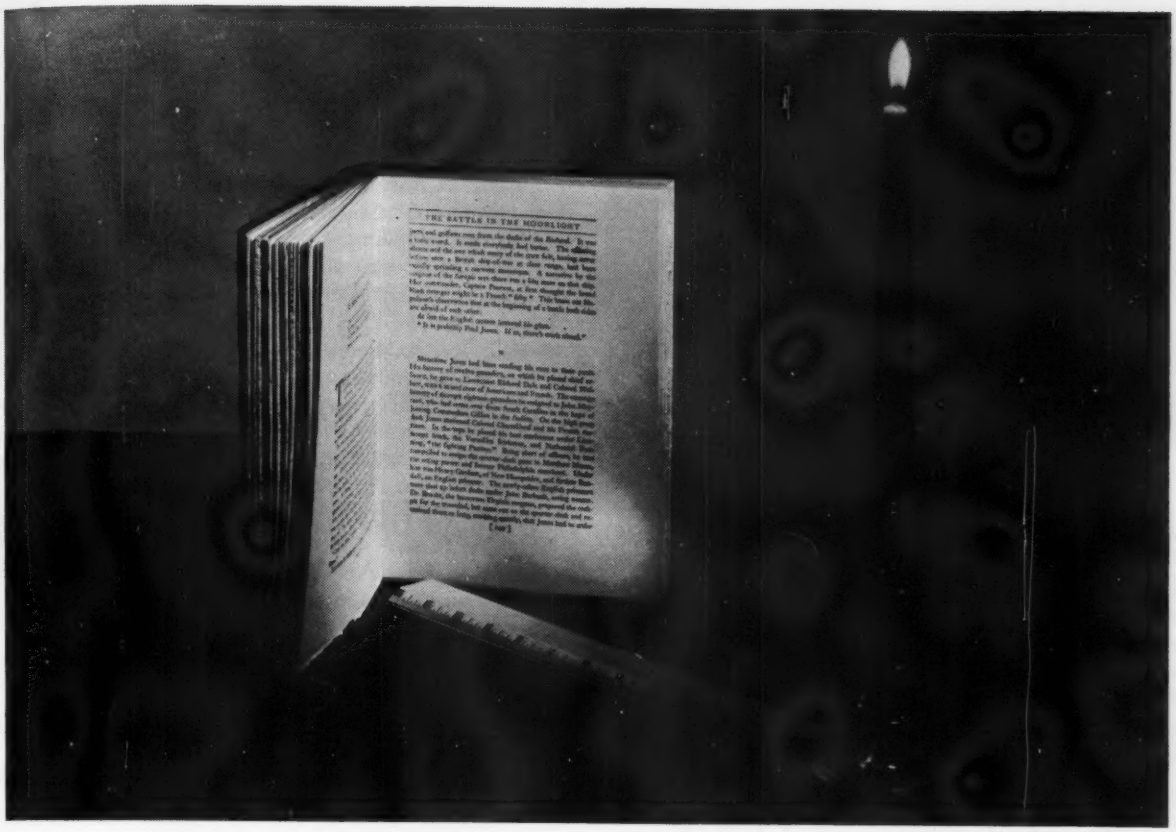

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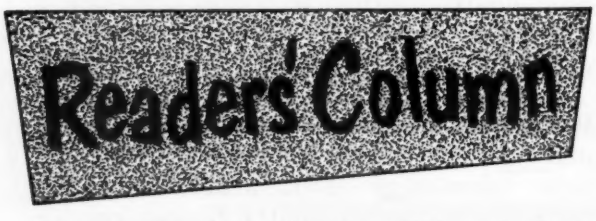
MT. WILSON-PALOMAR OBSERVATORIES

THIS MONTH'S COVER . . . is a pictorial interpretation of the theme of this month's lead article: *Science—The Endless Adventure*. It is a photograph of the radio telescope recently installed by scientists from the California Institute of Technology on Palomar Mountain in California, where, turned skyward, it listens for the incredibly faint radio signals that reach the earth from millions of miles away. These signals are natural phenomena and there is neither hope nor fear that they are being broadcast.

The first of several parabolic reflectors planned by Caltech, this telescope, with a reflecting area of more than 800 square feet, is not particularly large, measuring 32 feet in diameter. But it is expected to channel knowledge of inestimable value to those who are working today in the modern science of radio astronomy, one of the great adventures which Dr. Lee A. DuBridge, President of Caltech, discusses in the lead article which begins on page 273 of this issue.



The recent special-mailing item, *This is du Pont: The Story of Science in Industry,* impressed me and other faculty members here very much. We think it one of the most interesting and useful publications of its kind that we have seen. Our thanks to you and the sponsors for this commendable contribution to the creating of interest in and for science.

JOSEPH B. SMITH
Director, Science Instruction
Classical and High School
Salem, Massachusetts

This note may be late, but we do want you to know how very much we appreciated the opportunity to participate in the 1956 National Science Teachers Association Convention through the exhibit and film preview showings.

During the few years we have been engaged in this program, numerous conventions have been attended but certainly none that aroused the deep interest experienced at the NSTA meeting. A host of new friends was one result, and many, many science teachers became acquainted for the first time with this material. Quite naturally, we are looking eagerly forward to the 1957 Convention in Cleveland.

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U. S. Government agencies as well as industry and other groups are constantly informing NSTA of such worldwide job openings. NSTA does not and cannot make recommendations, but is glad to pass on biographical and related data on men and women who, from details submitted, seem to fit the specifications.

So—If you are considering the advantages of either a temporary or long-term assignment abroad, file information about yourself at NSTA headquarters, 1201 Sixteenth Street, N.W., Washington 6, D. C., including the following facts: Your name and address, of course; your present position; a brief biography on your career, educational, and geographic backgrounds; your family situation, i.e., your marital status and children's ages if they will go with you; what world areas you prefer and whether an urban or rural locality; and your salary, type of work, and job-term preferences.

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Teacher exchange opportunities in various parts of the world under the International Educational Exchange Program (Fulbright and Smith-Mundt Acts) are described in a special booklet. It can be obtained from the U. S. Office of Education, Department of Health, Education, and Welfare, Washington 25, D. C.

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- The Development of Scientific Laboratories
- How to Evaluate a Field Trip
- Report on the 1956 West Coast Summer Conference for High School Science Teachers

Editor's Column

This month's guest editor is William H. Eisenman, Secretary of the American Society for Metals.

Time doesn't seem to diminish my sincere regard for the science teacher and his or her job.

Perhaps it is that through the haze of changing years I see myself behind the reading desk as a chemistry teacher, eager then, as I am now, to see signs of inquiry on the faces of youngsters—youngsters among whom later will rest the grave responsibilities of scientific progress.

Good teaching was then, as it is now, a dedication of principles and a profession with great powers for good. I believed this these many years ago when I was a teacher, when I became a school principal, and still later when I assumed the responsibilities of school superintendent. I believe it with equal conviction today.

As of now, I am just a spectator in lecture halls and laboratories, but as such I also look upon both of these facilities as the repositories of truth and the forums in which our young generation can learn about the nature of all things—from unsaturated hydrocarbons to the Brownian movements. All of which, I believe, adds up to the teaching of *interest* in scientific subjects. Without interest, without a sincere inquiry into the yet unknown facets of a subject, learning loses one of its greatest values—the urge to know more than is being taught.

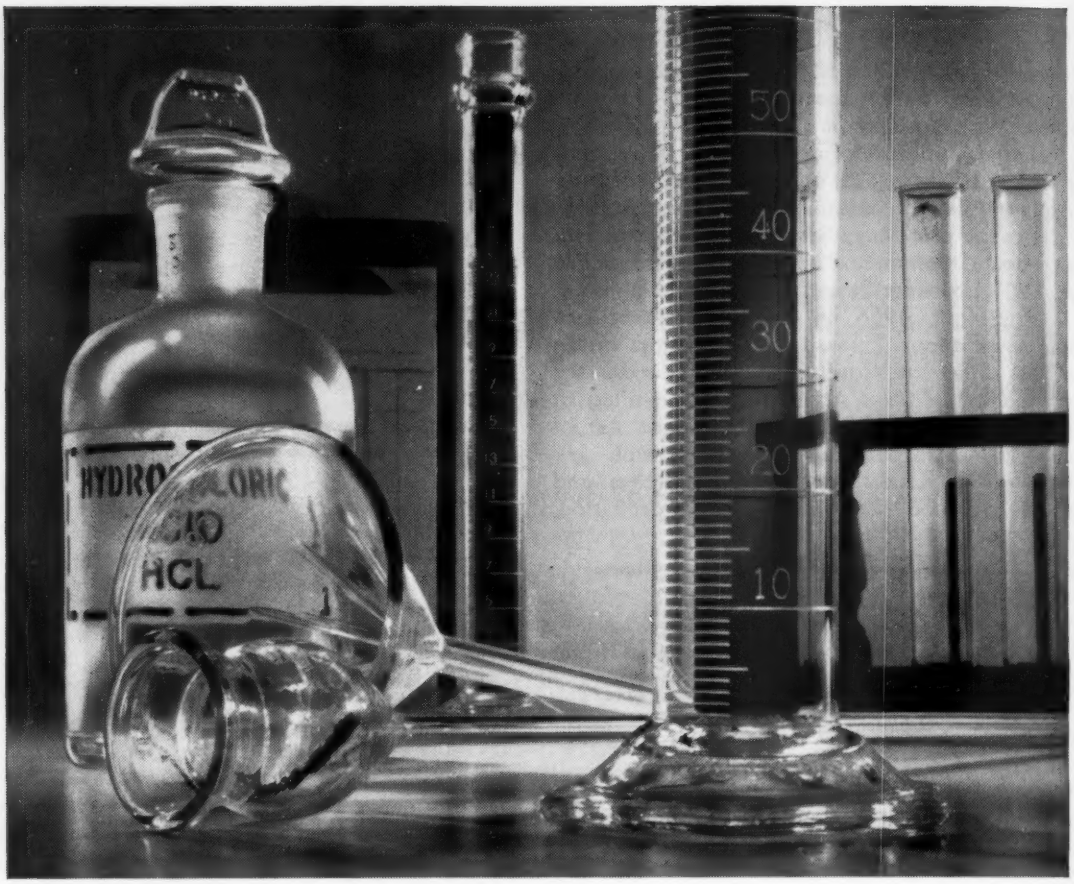
I'm reminded of an instance where hundreds of young students were attending chemistry lectures and laboratory exercises in schools located just across the river from a city in which a national convention of chemical scientists was being held. The daily press was filled with stories about the progress in this science—some of the accounts spectacular, many of them affecting the daily life of everyone. What an opportunity to deepen student interest and bring an otherwise mundane study into the realm of adventurous truth. And yet, despite this great environment, the chemistry classes in the schools just across the river proceeded along their unmerry way with texts, test tube, and beaker.

What I mean by teaching *interest* in scientific subjects is to make them a part of life, to make them a challenge to the student.

I have known science teachers with great ability and with sincere purpose. I have known some who were generous in their willingness to tackle new methods; others with a traditional hardness that kept them fixed upon the text and formula. But I have never known a science teacher who was incapable of generating the excited interest which makes the difference between study for a grade, and the exciting adventure of learning.

The teaching of science can never be organized as a game. And yet I am certain that we will produce greater scientists and more of them because their early learning was made a part of that bigger question—how did it happen? When did it happen? How can we change it? Why do we need it? Where and how does it apply?

(Please continue on page 307.)



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THE SCIENCE TEACHER

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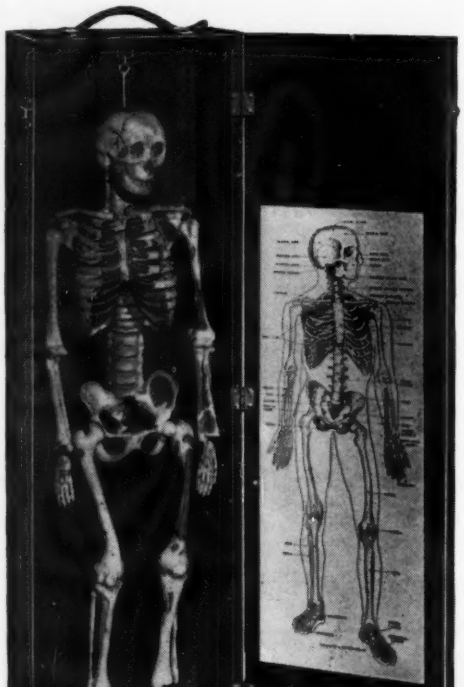

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SCIENCE
The Endless Adventure

By LEE A. DuBRIDGE*

President, California Institute of Technology, Pasadena

SCIENCE, I believe, should be discussed not in the light of the new technology to which it may lead, but for its own sake—as a method of thinking, as a method of acquiring new knowledge, as the key to understanding, the road to comprehension of the physical world. This is science, the endless adventure.

From the day that man first acquired consciousness, he began to observe the things about him—the nature of fire, of water, the winds, the sea, the stars. And as he observed, he remembered and reflected. He gradually gathered enough observations to demonstrate certain invariable regularities of nature which, reduced to their simplest form, we now call "laws of nature."

At a very early time, man must have been conscious of numbers, but primitive man had words for only three numbers—one, two, and "many." Gradually the "many" became sorted out—three, four, five, ten. Curiously enough, it was a very long time before he discovered the number "zero" and learned to use it.

Here we should reflect upon the science of mathematics. How many of us realize how utterly impossible our modern way of living would be without a number system and our science of mathematics. Suppose we had not yet invented numbers above ten. Suppose we had to add and multiply with Roman numerals. For example, how do you multiply XVI by MCMXL?

Suppose we were unable to deal with numbers higher than a million, or even a billion. How many people *do* know what a billion really means—or even a million? Counting as fast as one can—say three per second—it would take three days, 24 hours a day, to count to a million—more than eight years to count to a billion.

When we say that a modern hydrogen bomb has an explosive energy 20 million times as great as a one-ton TNT bomb, we have one of the spectacular illustrations of the importance of numbers in the modern world—the importance of being able to think in quantitative terms. Why do we still teach arithmetic as though numbers bigger than 100 or 1000 were too complicated to grasp? A million is 10^6, a billion is 10^9, a million squared is 10^{12}, and $10^6 \times 10^5$ is 10^{11}. It's simple! Even a little experience with exponents would give youngsters a lot of fun—and would make it possible for them, out of their own experience, to deal with millions and billions in a more meaningful way.

Our whole modern civilization is built on mathematics. Not a street can be laid, a foundation dug, or a building constructed without the use of algebra, geometry, and trigonometry. Not a machine can be designed, an engine's performance predicted, or an electric power plant constructed without mathematics through calculus. The design of airplanes, ships, or guided missiles requires a profound knowledge of higher mathematics. No one, in short, from a grocer's clerk to a nuclear physicist can do without mathematics.

A Journey to the Sun

Let us turn now to adventures in the world of physical science rather than mathematics: let us start the adventure with a journey to the sun.

The first thing we notice about the sun is that it is hot; very hot, in fact. The surface temperature is about 11,000° F, higher than any temperature ever observed on earth except in the burst of an atomic bomb. It is far above the melting point of any material we are familiar with, far above the boiling point of most materials. The sun, therefore, is very like a ball of hot gas.

But the surface of the sun is its coolest part. It is easy for an astrophysicist to prove that, because the sun is so massive and the gravitational forces are therefore so enormous, the sun would promptly collapse into a very much smaller object unless the

* A condensation of an address at the 94th Annual Convention of the National Education Association, Portland, Ore., July 6, 1956.

central part of the sun were at a very high pressure and temperature—in fact, the central temperature is more than 20,000,000° F.

The age-old question about the sun, of course, is —what keeps it so hot? We know that the sun has kept the earth at roughly its present temperature for four billion years or so. Where does all that energy come from?

Until recently—just before World War II—not even the beginnings of a satisfactory answer had been found. We know now that the only source of energy possible is the transmutation of matter—specifically, in the case of the sun, the transformation of hydrogen into helium. The sun would, in fact, explode like an H-bomb except that the gravitational forces are so enormous that it is all held together in a very nice balance. Fortunately, there is a lot of hydrogen still left in the sun—enough to last for another few billion years.

A History of the Stars

There is, however, a possibility that a great explosion might occur. We do not know precisely the conditions under which such stellar explosions take place, but explosions of distant stars have been observed in the heavens. They are known as supernovae. But on this point our knowledge is very vague indeed. In fact, it is only in recent months that a detailed quantitative picture of the evolutionary history of the stars and of the process of atom building has been worked out by combining the knowledge of astronomy with knowledge recently acquired in the laboratories of nuclear physics. Just recently, Dr. Fred Hoyle of Cambridge evolved a project for making detailed computations of the evolutionary history of the stars, a project which will require five years to complete on one of the fastest of modern computing machines.

This is one of the greatest of all adventures in science—the most daring, the most intricate. The sun is only one of a billion stars in our galaxy, and there are millions of other galaxies equally large scattered through space. The faintest that can be seen on the plates of the great 200-inch telescope at Palomar are two billion light years away. Yet we know that the same elements—the same kinds of atoms and molecules—occur in these distant stars.

This is one of the most exciting aspects of the great adventure of modern astronomy: the intimate way in which it brings together the sciences of spectroscopy, of nuclear physics, of electronics, of cosmology, of quantum mechanics, each one helping to fit in some piece of the vast jigsaw puzzle.

Students in high school and college ought to be introduced to this great adventure. Just as the youngsters of 100 years ago were excited about the pushing back of America's western frontiers, so the children (and adults, too) of today can reap equally great rewards from hearing about the frontiers of 1956—the frontiers of science.

There are other exciting developments in astronomy. Many years ago a radio physicist named Jansky was tracing some of the sources of noise in a sensitive radio receiver. There were faint hissing sounds which he could not trace to electric motors, spark plugs, thunderstorms, or the other usual sources of "static." He eventually found that these flickering radio waves were coming from the sun. So began the science of radio astronomy.

Today we know of hundreds of objects in the sky which are sources of radio waves. Some are stars like the sun; some are distant galaxies. Possibly the most interesting source is the great cloud of hydrogen gas which exists in the Milky Way galaxy and which gives off radio waves of a frequency of 1420 megacycles—a wave length of 21 centimeters, about eight inches.

Radio waves from the stars! What does this mean? In order to find out, great radio antennas, radio telescopes—far larger than the Palomar 200-inch, but less expensive—are being built all over the world to explore further the nature of the stars as revealed by the radio waves which the racing electrons in their outer atmosphere emit. Since radio waves penetrate air and haze and clouds with ease, a radio observatory does not have to be located in a clear climate or on a mountain top. The flat plains of Belgium and the clouded moors of England and Australia have been primary locations for radio work. They have there detected waves from sources which are so distant that for their waves to be detected here they must have been projected from a source as strong as a 50-kilowatt broadcasting station—multiplied a *million billion billion* BILLION times over! The power production is the inconceivably large figure of 10^{33} kilowatts. That much energy, were it much closer, would result in the earth being blanketed by so much radio "static" that radio and television broadcasting would be completely impossible.

We see then that astronomy, though it is one of the oldest sciences, is being rejuvenated even today. New telescopes have made our distance measurements more accurate; new electronic techniques are extending the power of both optical and

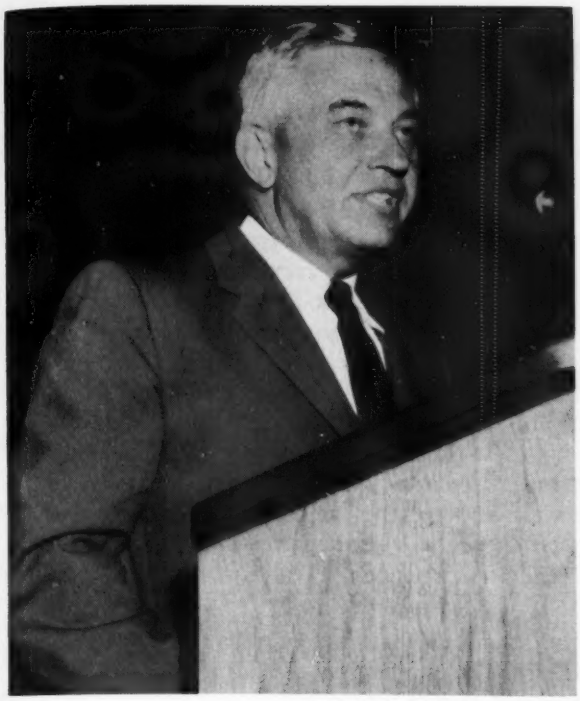


PHOTO-ART COMMERCIAL STUDIOS

Caught by the camera eye while speaking to the NEA convention, Dr. DuBridge shows his enthusiasm for his subject, "Science—The Endless Adventure."

radio telescopes; new knowledge of nuclear physics is helping us understand how the energy of stars is produced.

Back in the 15th century, we are told, so few people could read that there were millions of young people, contemporaries of Columbus, Magellan, and other early explorers, who never heard of their explorations, never knew a new world had been discovered, or that a ship had sailed around the earth.

Today we run the danger that, because our school children are unable to "read" the language of modern science, they will miss knowing about the great explorations of this generation—the intellectual examination of the frontiers of space. True, some day people may travel out into space beyond the earth. But such excursions will be limited. We could conceivably reach the moon in one day of travel at ten times the speed of sound. We could reach Mars in six months. But to come into the vicinity of even the nearest star would require 100,000 years. Hence, the only experience that human beings will have with the far reaches of space will be through the messages brought by light and radio waves. And even these, the fastest of all messengers, have been on the way for millions or billions of years.

So let us make it possible for our new generation to understand these marvelous adventure stories. The adventures, however, are by no means confined to outer space; there are adventures in each day's routine.

We arise in the morning to the ring of an alarm clock—an electric clock, no doubt, synchronized within seconds to millions of other clocks all over the world. Synchronization is achieved by the miracle of alternating current in our power lines, connected in a network extending hundreds of miles, and connected by radio to other networks far away.

So, even before we awake in the morning, our adventure has begun. We get out of bed, put on nylon hose, a dacron shirt, or an orlon sweater—fabrics made of chemicals obtained from coal and air and water.

Breakfast is another kind of adventure—food from the far corners of the earth, prepared over a flame which burns gas piped from Texas. And as we eat we read of world events only a few hours old—stories, even pictures, which have been flashed with the speed of light from London or Calcutta. Only a few years ago, less than 100, a famous British physicist, Lord Kelvin, slaved away years of his life supervising the laying of a cable across the Atlantic through which feeble electric impulses could be slowly pushed—dot—dash—dot.

After breakfast, we step into a real miracle—the automobile. We seldom look under the hood to see the bewildering array of examples of the laws of thermodynamics, of mechanics, of electricity, of metallurgy—of almost every science and technology. All we care is that this device converts a gallon of gasoline into many miles of travel.

The Expense of Secrecy

Then, as we read the news—possibly reporting our own scientists visiting the Soviet Union and finding themselves in full agreement with the Russian physicists on the best design of a synchrotron—we discover another example of the fact that adventures in science are international. All countries agree on the laws of physics. We may fight over the writings of Karl Marx—but not over those of Isaac Newton or Albert Einstein. Politics cannot for long suppress the facts of nature. We have tried it here, too. We thought nuclear physics could be kept secret; we forgot that scientists in other countries can ask questions of nature, too—and get the same answers we do. We also learned that secrecy in science is very expensive, for

secrecy impedes the advance of science and also the advance of technology.

But our day's adventures have only begun. We drive by a TB sanitarium that is being closed—for lack of business; pass a hospital where once-fatal illnesses are cured in a few days; see some youngsters getting polio shots and know that another dread disease is on its way to extinction.

The Study of Viruses

Still another new adventure for us: the giant strides being made in the unraveling of the chemistry of living things. The properties and behaviors of viruses can be studied now with all the modern techniques of physics and chemistry—not solely by trial and error, but by systematic analytical methods. One by one the different harmful viruses will be isolated, bred, and studied until methods of destroying or controlling them are evolved. Beneficial viruses—those that kill harmful bacteria—will also be studied and used in the control of other diseases. The days of bacterial and virus diseases are numbered. It may be years and there will be some exhausting struggles, but these elementary substances now can be understood and controlled.

These adventures of ours are daily getting more exciting. They are adventures that more and more people will eventually participate in. The fraction of the United States working force engaged professionally in scientific and engineering pursuits has multiplied by five in the past 50 years. It can't multiply by five again or it would approach 100 per cent. But it may well double. The need is great and the opportunities are endless. The great challenge of our school system is to help every child with potential talents develop them to the utmost.

But men and women without professional interests in science may still enjoy these adventures of science. The language of the atom can be learned. After all, people enjoy music who do not perform. People enjoy literature who do not write. Lawyers and businessmen and English teachers have learned to enjoy science.

The exciting adventures of science have a great immediacy. From morning alarm to evening TV program, we are living in a world which has resulted from adventures in science. Just as the great adventure of Columbus opened a new continent, so the inspired adventures of many scientists—Galileo to Einstein; Faraday to Edison; and thousands of trained men and women working today in laboratories throughout the world—have created on this new continent a new kind of civilization. There are certain things about this civilization that we are not satisfied with. But the defects will be fixed by those who understand the nature of the world in which we live. The world will be made better by knowledge, not by ignorance.

But the adventures in science are not only fun; they are an essential part of our everyday intelligent living. We spent strenuous efforts in this country to reduce illiteracy, to make it possible for every man, woman, and child to read and write. Now we face a new type of illiteracy in which citizens are unable to read and understand the things about which they must make decisions, all the way from spending billions on nuclear energy to investing a few thousand dollars in a new chemical company; decisions as to what to do about smog; about putting fluorine in drinking water; about paying higher salaries to the very important teachers of science.

What, we may ask, does all this have to do with the school teachers of America? This, I think, is clear: The making of the future scientist or the making of the future intelligent citizen begins in the fifth grade or before, and continues at all levels through the university graduate school. Except for a very few unusual individuals, scientists and engineers are made, not born. Interest and facility in mathematics and science are created by fine teaching; by intelligent, sympathetic interest in the individual; by the uncovering and stimulating of exceptional talent; by making the subject matter exciting rather than dull.

But there are certain illusions about science and mathematics that must be eliminated before the adventures of science can be appreciated and advanced more rapidly in our nation.

The False Illusions

The first illusion is that mathematics is too hard for young minds to grasp. That is false. Properly presented and properly taught, mathematics is an exciting adventure — especially for youngsters. What has made it seem hard is the endless procession of dull and useless problems which are normally taught. "How many square rods in 19½ acres?" or "If A has three apples and B has twice as many as A and C together . . .?"—you know the kind. Why crush the glorious excitement of the great principles of algebra, geometry, trigonometry—yes, and calculus—with an avalanche of useless detail? I suggest that to prepare a really first-class series of 7th- to 12th-grade texts on

(Please continue on page 307.)

Criteria for Sponsored Teaching Aids in Science Education

By SAMUEL SCHENBERG*

Supervisor of Science, New York City Board of Education

THE PRESENT SHORTAGE of scientists, engineers, and science teachers has focused the attention of the United States upon our schools. It has brought about a realization of the crucial role of science in this second half of the 20th century. One of the heartening results of this attention has been the increasing interest of industry in the raw material of our educational system—our children. This raw material must be leavened into the scientist, the engineer, and the science teacher of tomorrow if we wish to preserve our way of life. That industry has chosen to participate in this important undertaking is evidence of its far-sightedness and its civic-mindedness.

For many years industry has made available valuable resource material for use in our schools. This material has taken the form of booklets, charts, maps, photographs, films, filmstrips, kits, models, and even science assembly programs. These offerings have been aimed at different levels and subject areas. The science area has come in for a lion's share. The industrial resource material usually explains different aspects of the particular industry's functions and operations. Many teachers in New York City and throughout the country find this material of great interest and value in their classrooms. The material may come into the school with or without solicitation by the school. At times, however, it arrives at the school without a clear idea of the uses to which it may be put. At such times it fails to justify the labor and expense connected with its preparation and distribution. To avoid this last possibility, I will try to discuss briefly, from the standpoint of a supervisor of science in the New York City schools and a consultant on industry-sponsored teaching aids, some of the important criteria for determining, in advance, the probable effectiveness of teaching aids in science teaching.[1]

Sponsored science teaching aids must meet a dual purpose. They must help to attain the objectives of the sponsors *and* the objectives of the science program in our schools. Long association with industry on such matters leads me to believe that industry has at least four objectives in mind: (1) a desire to acquaint teachers and students with the industry's contribution to the American way of life through its method of operation, its products, and their uses, (2) a desire to secure and foster good public relations, (3) a desire to provide up-to-date scientific information of immediate assistance to science teachers and science students, and (4) a desire to acquaint students with the possibilities and opportunities for science careers.

The objectives of the science program in our schools include all of the objectives for a good general education. A good science program will aim, also, at four specific science objectives: (1) the acquisition of a functional understanding of the scientific facts, principles, and concepts which operate in our environment, (2) the attainment of adequate skills, habits, and attitudes in the use of problem-solving methods that are involved in scientific investigations and explorations, (3) the inculcation of an appreciation of the contributions, potentialities, and methods of science for the improvement of human welfare, and (4) the development of an interest in science as a vocational and/or an avocational activity.

The effectiveness of an industrial educational program may be evaluated, therefore, upon the extent to which it is able to attain these objectives. A failure on the part of industry to operate on this basis will inevitably result in the piling up of industry-sponsored aids on storage shelves without effective use by the teacher or the students and, of course, without gain to the industry.

I am sure all of you realize that teachers follow a carefully conceived and prepared course of study.

* A talk delivered at the Spring Workshop of the New York Chapter of the Business-Industry Section of the National Science Teachers Association, New York City, April 24, 1956.

[1] The Packet Service of the National Science Teachers Association, now in its ninth year, has provided invaluable assistance relative to improving the quality and the effectiveness of sponsored teaching aids for science. More than 100 science teachers help in the evaluation of such materials prior to distribution. The Association also provides consultative and advisory services at low cost for sponsors who wish to avail themselves of "grass roots" advice in the design of teaching aids.

The course of study is usually designed for completion within a school year. It is sufficiently flexible to permit the exploration of new and related avenues of interest by the alert and up-to-date teacher. An industry-sponsored aid which will assist the teacher in the presentation of any topic or unit in the course of study will be welcomed with open arms. Aids which will supplement the course of study will be used if the teacher is acquainted with their important relation to and connection with the course of study. Many teachers are also continually on the lookout for supplementary aids to stimulate the more able or more interested students to work independently on individual projects or in groups as a club activity. Science teachers are always interested in good displays which may take the form of interesting and attractive posters, charts, and exhibits. These are valuable for use in display cabinets in classrooms, laboratories, and corridors outside of the science rooms. Industry-sponsored aids which are not specifically oriented as I have just indicated are usually of little value to our schools.

The New York City Board of Superintendents adopted on May 20, 1952, a list of "Guiding Principles for School Selection and Use of 'Non-Listed' Instructional Materials not Purchasable Through School Allotments."[2] I have selected for your consideration ten of the criteria listed therein. The industry-sponsored aid should:

1. Make a significant contribution toward the attainment of educational objectives.
2. Treat the subject competently and accurately.
3. Be timely and suitable for the interest level and experience background of the pupils and at the same time be suited to the level of the pupils in language, diction, and literary quality.
4. Possess a mechanical make-up and technical quality appropriate to the use intended and also involve a minimum of physical strain or fatigue.
5. Harmonize with American democratic ideals and moral values.
6. Be free from any reflection upon the dignity and status of any group, race, or religion by statement or omission.
7. Be free of objectionable features of overdramatization, violence, or crime.
8. Keep the advertising content at a minimum.
9. Be sponsored by an industry as a whole rather than by an individual company intent upon the sale of its products.
10. Be acceptable to the principal of the school.

[2] The preparation of similar lists of criteria or guiding principles by Boards of Education or the school staff is not uncommon.

The ten criteria are, I believe, perfectly clear and reasonable. Perhaps numbers 3 and 9 deserve a little amplification. If you picked up a textbook used by an eight-year old elementary pupil and compared it with a physics textbook used by a 17-year old high school student, you would not only notice a difference in the titles but would also recognize the great variation in size of type, vocabulary, illustrations, ideas, subject matter, and general format. A good textbook publisher pays careful attention to the age level, interests, and backgrounds of the reader. The same guiding principle applies to all teaching aids. The same guiding principle applies with equal force to industry-sponsored teaching aids. Educational systems and teachers do not look with favor upon sponsored material filled with advertising matter. There is a great distinction between sponsored material whose only reason for existence is the thinly veiled attempt to sell a specific product and the sponsored material which attempts to explain science concepts and principles connected with the manufacturing process presented in the name of an individual company.

The New York City schools discourage individual requests by children for sponsored aids. If the material is useful, we prefer to order it in classroom lots and have the teacher distribute it.

The science area offers a particularly fertile field for the introduction of industry-sponsored teaching aids. Science teachers find it difficult to keep up to date with the tremendous changes that are taking place in industry due to the discoveries being made in the research laboratories. Industry therefore has an opportunity to provide the teachers with the latest advances in science and the contribution these advances in science are making to the growth of the industrial life of this country. Teachers are quick to realize the motivation that results from the use of such up-to-date sponsored material. With them, science teaching takes on new dimension, new interest, and higher effectiveness. The science student realizes the importance of what he is studying and sees its connection with the world in which he lives. Therein lies the greatest contribution of industry-sponsored aids. The objectives of industry and education become fused and the maximum utilization and appreciation are assured.

I would like to close by suggesting that even the best science teaching aid will find a greater market if it is introduced into the school system at a meeting held with appropriate representatives of the science director, supervisors, and classroom teachers.

Development of High Level Science Talent

By SHERMAN ROSS, VICTOR H. DENENBERG, and RANDALL M. CHAMBERS*

R. B. Jackson Memorial Laboratory, Bar Harbor, Maine

THE needs of our society for the identification, encouragement, and development of high level scientific talent is, by now, a well-known problem. Though the number of students matriculating in science or engineering is increasing, the percentage engaged in these careers has been decreasing so that now less than 0.5 per cent of our total population are scientists or engineers (see Reference 6).

One reason that this shortage of trained scientific personnel has been of concern is the practical one of military advantage. Reports indicate "... that the annual number of graduates in science and engineering has become greater and is increasing more rapidly in the Soviet Union than in the United States" (12, p. 1125). It is not unreasonable to assume that the nation with the greatest scientific and technical manpower will have a marked advantage if international hostilities should occur again, and it may well be that we are liable to be exceeded in this manpower potential.

Another reason for concern, over and above the military problem, is that the general betterment of society through scientific and technological advances can be made only when there is a sufficient quantity of adequately trained, competent personnel to work in these requisite areas. This point has been admirably stressed by Dael Wolfle, formerly Director of the Commission on Human Resources and Advanced Training, in his book, *America's Resources of Specialized Talent.* He states: "The brains of its citizens constitute a nation's greatest asset. From the minds of men will come future scientific discoveries, future works of art and literature, future advances in statesmanship, technology, and social organization, in short, all future progress. . . . The practical problem becomes one of devising the best means of mustering the talent which exists in the population" (10, p. 283).

* Sherman Ross is a Scientific Associate in the Department of Psychology at the University of Maryland. Victor H. Denenberg, a Carnegie Fellow in the summer of 1955, is associated with the Department of Psychology at Purdue University. Randall M. Chambers, a Research Associate at the Jackson Memorial Laboratory, is currently Chief of the Trainer Skills Branch at the USAF Personnel and Training Research Center, San Antonio, Texas.

A method for "mustering the talent" has been suggested by Wolfle in a recent editorial in *Science* (11). He has challenged college science departments to take part in the problems which our nation faces regarding competent high school science instruction by making the preparation of high school science teachers an explicit function of college science departments.

Another approach has been suggested by Johnson (5) who describes a "science camp" conducted during the summer at Florida State University. High school students who attended this camp were exposed to laboratory work, field trips, demonstrations, and informal discussions with science staff members in ten different scientific areas. Johnson concludes his summary of the program with the statement that ". . . further activities along these lines can do much to help alleviate the shortage of trained people that has been the cause for much justifiable concern" (5, p. 39).

Still another means of nurturing scientific talent, somewhat akin to Johnson's proposal, was conceived a number of years ago by C. C. Little and carried forward by him and his colleagues. This is the Summer Research Apprenticeship Program at the R. B. Jackson Memorial Laboratory in Bar Harbor, Maine (14). At this Laboratory, devoted to biological and behavioral research, students at both the high school and college level work with regular staff members or visiting scientists on a variety of research problems. Students accepted in the program have already indicated a major interest in the life sciences and are believed to have high potential for becoming competent research scientists.

Since these students are "high science potential," it seemed to us that an effort should be made to determine some of the factors which may have influenced them to select science as a probable career. Knowledge of these factors would appear to be helpful in the identification, encouragement, and development of scientific talent (3, 4, 8).

It is the purpose of this report to describe some of the characteristics of the high school students who participated in this program, to introduce the pre-collegiate program at the Laboratory, and to

bring to the attention of teachers their role in the development of scientific interest in their students.

Method and Procedure

The sample for this study was 26 superior secondary school students who spent the summer of 1955 at the Jackson Memorial Laboratory in the Science Research Apprenticeship Program for Pre-Collegiate Students. Twenty-one of these students (11 male, ten female) had been competitively selected from 76 applicants in 15 states. The remaining five (two male, three female) were second-year students who, on the basis of their performance during the previous summer in the program, had been invited to return.

The students had just completed either their junior or senior year in high school. The median age of the sample was 16 years, 11 months; and the range was 15 years, two months to 18 years, seven months. All students had been highly recommended by at least one science teacher and one other qualified person. Character references and health reports were also required. All students had made superior grades in high school and had indicated an interest in a career in the life sciences. Each student had been judged by the Laboratory's selection committee as having a superior potentiality for becoming a research scientist.

We are well aware of the small size and the possible bias of our sample and the possible fallibility of the selection procedures by which these students were chosen. However, the continued success of students who have attended the apprenticeship program in the past seems to suggest that the students in the program come from a population of potential future scientists. It is this population in which we are interested.

Secondary school students with "high science potential," who were the subject of the study reported on these pages, carried out many experiments during their summer research at the Jackson Memorial Laboratory.

During his first week at the Laboratory, each student was given a series of tests designed to obtain an independent estimate of his scientific abilities, aptitude, interests, and personality adjustment (a). In addition, each student was given the following essay question and asked to turn in the requested essay within five days:

Would you please prepare an autobiographical sketch of not more than 1200 words, stressing those factors in your personal background and experience which have affected the development of your intellectual interests, and mentioning particular persons or events which have been most influential. The sketch should conclude with a statement of the rewards you hope to derive from your future career, and your reasons for choosing a particular vocation or alternative vocation (b).

Each student received the question in a sealed envelope, and was instructed not to discuss the nature of his question or his essay with any other person. The student was not required to sign or identify the essay which he submitted.

In analyzing the essays, we carefully went through Wilson's paper (9) and constructed a series of items concerning the same factors discussed by him. We then went through each of the essays and tabulated for each student his responses in the appropriate categories.

Results and Discussion

We are particularly concerned here with the essays submitted by the students in response to the above essay question. The table presents the major findings of our content analysis of these essays. It is apparent from the size of our sample and the frequency of responses for some of the items that any attempt at a statistical analysis of the data would be foolhardy. We do believe that some responses stand out in regard to frequency of occurrence or in respect to lack of importance to be worthy of comment.

One of the factors of greatest importance is concerned with the people and events which have influenced these students to go into science. By far the greatest number pointed directly to the influence of teachers. Sixteen made reference to high school teachers of science or mathematics, and eight made reference to grade school teachers. Other people of influence were parents (primarily the father), physicians and scientists these students

had met, and other relatives or family friends. The influence of mothers, peers, and siblings was not reported to any major extent.

SUMMARY OF MAJOR FINDINGS OF CONTENT ANALYSIS

Category		*Frequency*
Factors Influencing Intellectual Development		
High school teachers of science or mathematics		16
Grade school teachers		8
Parents		8
Father	6	
Mother	2	
Other relatives or family friends		8
Physicians or scientists		6
Peers and siblings		1
Books		10
Church		3
Reasons for Going into Science		
Acquire knowledge, self-satisfactions, curiosity		19
Contribute to society		13
Influenced by summer jobs or experience		7
Obtain community status		1
Financial rewards		0
Fields of Concurrent Interest		
Humanities		6
Writing		6
Music		6
Philosophy		3
Mathematics		3
Art		2
Social sciences		1
Physical sciences		1
Vocational Choices		
Medicine		9
Medical research		5
Science		4
Biological research		3
Medical missionary		1

Another interesting finding is the number of details these students mentioned regarding their early experiences. The array of early events listed by the high school students as influencing them are impressive. These included chemistry sets (5), bird watching (3), flowers (1), insects (5), map (1), Girl Scouts (1), basement laboratory (3), snakes (1), and being a winner in a science fair (8). The influence of books and the church are worth noting here also. Those who mentioned books indicated that they had been intellectually stimulated by their readings, while those mentioning the church indicated that the motivation here was that of helping society.

Some of Wilson's findings on superior college students in the social sciences are similar to what we obtained from these high school students. He reports that the college social science major lists college professors as being the most influential, followed by fathers and high school teachers. However, he also reports that ". . . if one were to rate the references on a scale of magnitude based on the feeling-tone and the amount of detail given by the student, high school teachers would probably be found in the top position. . . If they (high school teachers) are as potent in recruiting scholars as these data suggest, then recruitment policy in the social sciences should include winning the active participation of secondary school teachers" (9, p. 26).

Two skilled science students are pictured in a typical summer scene at the Jackson Memorial Laboratory.

This statement appears to be just as valid for students in the biological sciences as well. Many of the high school students gave the names of teachers in science and indicated the major effects these teachers have had upon them. Similar essays from college and post-college students in the program do not yield such frequent references to the earlier years. College students seem to be impressed with college professors!

The failure of the college students to mention much about their pre-high school life is of interest. It may be that for these groups nothing of importance occurred prior to high school. However, this seems doubtful, and a more reasonable hypothesis would be that the transition to college life, accompanied by all the new experiences and rapid changes, have helped these students forget about early events which have indeed been influential in guiding them into scientific fields. If this is true,

(Please continue on page 301.)

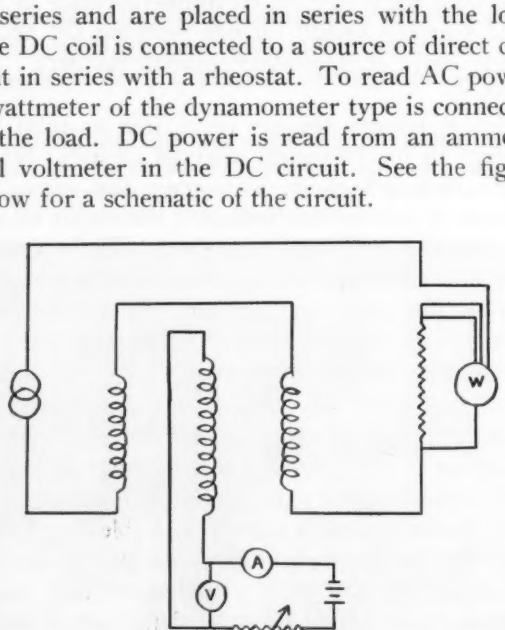
A SATURATING CORE REACTOR FOR THE PHYSICS LABORATORY

By FREDERICK B. EISEMAN, JR.

John Burroughs School, St. Louis, Missouri

IN connection with the teaching of magnetism and later of inductive reactance, the author has found that an illuminating demonstration can be made with a saturating core reactor. This paper would not be justified if it were merely to report upon the existence of such devices and their theory of operation, because at least two excellent books are currently available[1, 2] and a recent article generally available to science teachers has described such a demonstration[3]. The purpose of this article is to describe how such a device can be easily constructed for less than $15.

Briefly, a saturating core reactor is a device whereby a comparatively large amount of alternating current power can be controlled by a very small amount of direct current power. In its usual form, it consists of a three-legged transformer core, upon the outer two legs of which are wound the AC coils and upon the center leg of which is wound the DC or control coil. The AC coils are wound in series and are placed in series with the load. The DC coil is connected to a source of direct current in series with a rheostat. To read AC power, a wattmeter of the dynamometer type is connected to the load. DC power is read from an ammeter and voltmeter in the DC circuit. See the figure below for a schematic of the circuit.

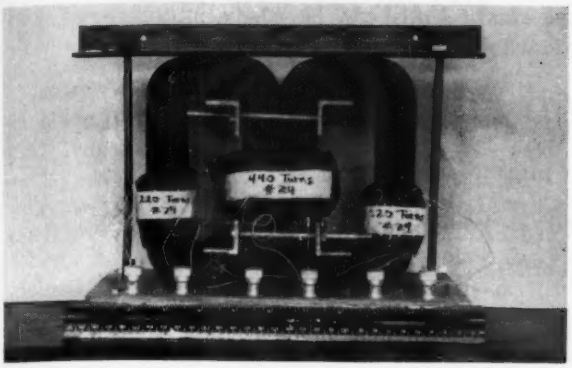


The AC coils wound on the iron core constitute an ordinary choke. If the AC power is turned on without the DC coil being activated, very little if any current will flow because of the large inductance of this choke. This inductance is attributable, of course, to the back emf generated in the AC coils by the alternately expanding and collapsing magnetic field of the 60-cycle AC. The back emf is caused by lines of force which concentrate in the laminated iron core. Without a DC control coil, the magnetic lines of force of the AC coils are numerous. That is, the flux density is high. A large back emf reduces the current to a negligible value.

The material of the reactor core is especially chosen so that it will saturate readily. That is, a rather small change in the magnetizing force will produce a large change in the flux density of the core. If the magnetizing force is increased beyond a certain point, the flux density in the core stops increasing in proportion to the magnetizing force and reaches a plateau, wherein a large change in magnetizing force increases the flux density very little. This is the saturation point of the core. The saturating core reactor is made of a material that saturates very readily.

Now if a small DC current is passed through the control coil wound on the center leg, thus increasing the magnetizing force, the core will saturate. The lines of force due to the alternating current can no longer increase, because the core is saturated. Thus, the counter emf is reduced and the AC current flows. The greater the DC current, the more nearly the core saturates, the smaller the flux density of the AC, and the more AC current will flow. Thus, the inductance of the AC choke is readily decreased.

Ordinary silicon steel transformer laminations would probably give satisfactory results. However, there is available on the market a material that is extremely readily saturated and which is already fabricated in a form handy for construction. This is Hypersil, a trademark of the Westinghouse Electric Corporation. It is a high-permeability silicon steel that is fabricated in laminations, thus reduc-



ing eddy current losses, and which is available in so-called C cores. These cores are actually rectangular in shape and are sawed in half near one of the small ends. This makes it easy to slip an already-wound core over the core material and replace the end piece, thus making a closed magnetic circuit. The cut ends are accurately machined to give as small an air gap as possible.

Since three legs are required for the reactor, two cores are necessary. Westinghouse No. A-417 cores are about the correct size for this reactor, measuring approximately 4 x 7 inches, with a 1⅛ x 1½ inch cross-sectional area. The coils were wound on a wooden core that had a diagonal cut so that the core could be removed when the winding was finished. The wood core was cut slightly larger than the cross-sectional area of the core of the reactor. Ordinary plain enamel magnet wire, readily available from radio houses, was used. The AC coils were wound to slip over the 1⅛ x 1½ inch core cross-section. The DC coil had to slip over a double cross section, because the center leg of the reactor is composed of one side of each of two cores, as can be seen from the photograph.

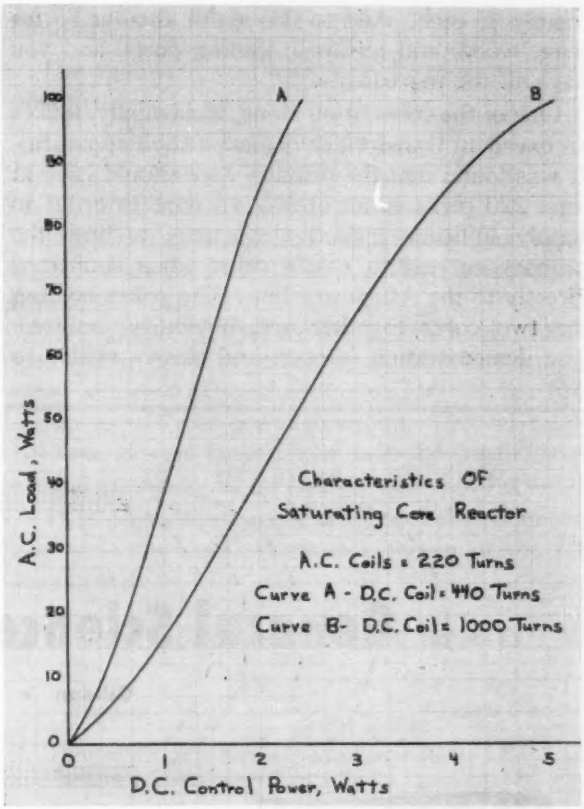
The leads from the three coils were attached to regular binding posts for ease of connection. The entire assembly was placed upon a wooden base, and a yoke made of ¼ inch steel rod was provided to hold the top pieces of the cores down solidly on the coil bearing parts of the core. The rod was bent into a U, the vertical arms projecting through the board from below and up beside the core. A piece of angle iron was used to clamp down the top, containing two holes to take the threaded ends of the U-shaped rod, which was then fastened by wing nuts.

In order to hold the two cores back to back, another pair of yokes was made from angle iron, readily visible in the photograph. AC coils of 220 turns were used with DC coils of 440 turns and 1000 turns. The coils can be replaced in less than a minute by unscrewing the wing nuts and removing the top of the cores.

One or two 150-watt incandescent lamps were used as the AC load, and DC was provided from a Heathkit Battery Eliminator, although almost any low-voltage source would have done just as well.

Two curves are included that show the characteristic curves for the reactor. These curves were obtained by two advanced students working on the equipment as a special project.

The slope of the 1000-turn DC coil curve shows an amplification of approximately 45. The 440-turn DC coil amplification is about 50.



This device can be used in the physics class to show the principles of inductance, magnetic saturation, and magnetic amplification. It is a practical control device, because no heat is dissipated in the core due to resistance as would be the case with a rheostat. If a large capacitor is connected in series with the load, a most interesting effect is produced. The inductance of the core plus the added capacitor produces series resonance in the AC circuit. This decreases the impedance to a low value and the current will surge upward. This current surge, however, will increase the impedance of the reactor and detune the circuit. The impedance increasing

decreases the current. But a decreased current decreases the impedance to the resonant value, and the action continues. The rate of pulsation of the circuit is varied by changing the series capacitor or the DC current or both. We have achieved pulsating AC currents from approximately one second in frequency up to a very fast and more or less uncountable rate. The load lamps, especially at the low frequencies, produce a striking effect as they vary from almost off to almost full brightness. Of course, this idea has many practical applications as well. For example, the surges of current could be used to fire off a thyratron-controlled circuit.

We purchased the Hypersil cores for approximately $5 each. Add to this about another $5 for wire, wood, and terminal binding posts, and you have all the ingredients.

One of the cores, used alone, incidentally, makes an excellent transformer demonstration apparatus. It was found that the primary core should have at least 220 turns of about No. 18 wire in order to supply sufficient inductive reactance to limit the primary current to a safe value when connected directly to the AC power line. The yokes holding the two cores together are, obviously, omitted. The demonstration is open and clearly visible to the class. Coils can be easily interchanged, and the whole action clearly understood.

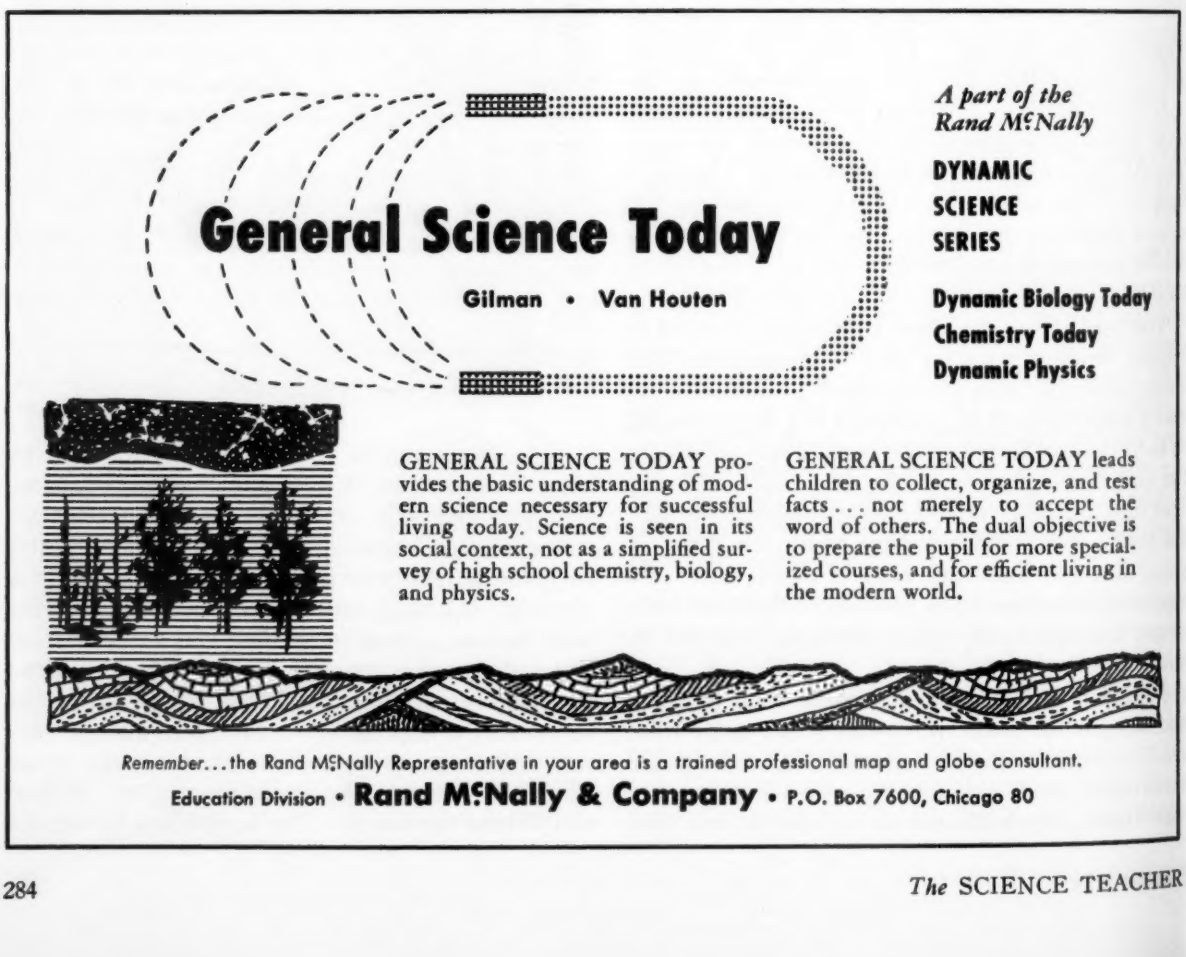
References

[1] GEYGER, WILLIAM A., *Magnetic-Amplifier Circuits.* New York: McGraw-Hill Book Company, Inc., 1954.

[2] CROW, LEONARD R., *Saturating Core Devices.* Vincennes (Indiana): Scientific Book Publishing Company, 1949.

[3] EWING, GALEN W., "Saturable Reactor, A Demonstration", *Cenco News Chats* (No. 81, 1955). Chicago: Central Scientific Company.

The Educational Policies Commission of the National Education Association and the American Association of School Administrators has been working for several years on a study of the manpower situation and its implications for education. The report of this study, titled *Manpower and Education,* has just been released. (Order from NEA, 1201 Sixteenth Street, N.W., Washington 6, D. C.; price, $1.25.) It is a reading "must" for teachers, administrators, counselors, and school board members. The report brings together widely scattered information about population trends and technological developments and relates it to educational needs and responsibilities. Implications for education include recommendations for schools, colleges, and agencies for adult education.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RETENTION OF LEARNINGS IN HIGH SCHOOL CHEMISTRY

By JOHN R. SMELTZ*

New Cumberland High School, Pennsylvania

Statement of the Problem

The problem of this study was to determine to what extent the learnings of high school chemistry acquired by pupils during the eleventh year of high school were retained one year following the completion of the course.

Related problems included those of evaluating the relationships of intelligence and retention, achievement and retention, and intelligence and achievement. Other problems were the relationships of retention and pupils' purposes in enrolling in chemistry, retention and pupils' preference of chemistry among other subjects, retention and taking a physics course following the chemistry course, retention and sex of pupils, and, as another problem, retention and different types of learnings of chemistry.

The Procedure

Data were collected from five public high schools of a county in Pennsylvania. The tests used were *Anderson Chemistry Tests, Forms Am and Bm,* and *California Short Form Test of Mental Maturity.* Two questionnaires constructed by the author were also used.

The chemistry tests were administered to 180 pupils of average intelligence enrolled in chemistry in the five schools for the 1953-54 academic year in September 1953, May 1954, and May 1955. These pupils also answered the questionnaires developed for the study.

Achievement was measured by the difference of the raw scores of the first two tests. Retention was measured by the difference of the raw scores of the first and third tests. Intelligence was measured by intelligence quotients.

Chemistry tests were also given to a group of 145 other pupils of slightly below average intelligence who were not enrolled in chemistry in the same five schools. These tests were given in May 1954 and May 1955.

Findings

The following coefficients of correlations were obtained:

1. Achievement and retention: .70
2. Achievement and intelligence: .51
3. Intelligence and achievement: .39

The mean of the college preparatory group was higher than that of the non-college preparatory group. The critical ratio was 4.91.

The means of the retention scores of groups arranged in order of preference of chemistry among other subjects diminished from 25.05 for the first group to 9.77 for the fifth group. Critical ratios between groups ranged from 6.16 for the first and second groups to .92 for the fourth and fifth groups.

That pupils liked some aspects of the chemistry course better than others was shown in the following table:

ASPECTS OF CHEMISTRY LIKED BY 180 PUPILS

Aspects	*Number of Times Checked*
Laboratory Work	160
Classroom Demonstrations	132
Motion Pictures	109
Application of Chemistry to Everyday Life	92
Equation Writing	68
Study of Chemical and Physical Properties	58
Study of Atomic Structure	54
Study of Atomic Energy	53
Others	4

The mean of the retention scores of the physics group was higher than that of the non-physics group. The critical ratio was 4.44.

The means of the retention scores of 105 boys

(Please continue on page 305.)

*An abstract of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education, August 1955, The Pennsylvania State University.

Insects in the Classroom

By JAMES G. LAWRENCE
Granite School District, Salt Lake City, Utah

IN THE STUDY OF NATURE there is nothing more interesting or amazing to elementary pupils than the world of insects. Of all man's competitors for survival on this earth, the insects are his greatest. They compete for the food he eats, lay waste to his potential lumber, infest his livestock, and destroy the animal fibers used in making his clothes and furniture.

Pupils will readily drop the term "bug" for every small creature of six or more legs if given the opportunity to handle and see at first hand the great variety of insects and spiders that abound everywhere. Many fears and superstitutions will be overcome by pupils when they discover the great variety of insects that can be handled harmlessly.

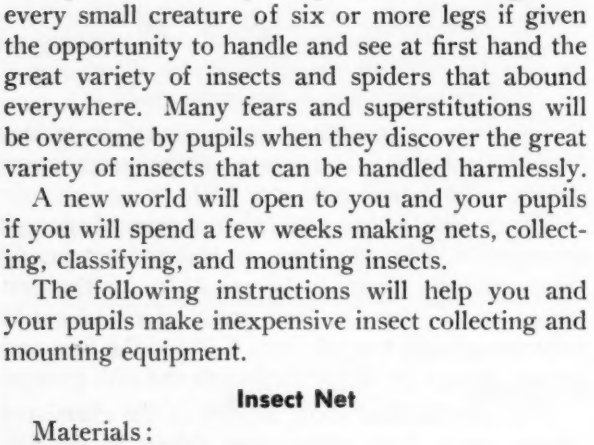
A new world will open to you and your pupils if you will spend a few weeks making nets, collecting, classifying, and mounting insects.

The following instructions will help you and your pupils make inexpensive insect collecting and mounting equipment.

Insect Net

Materials:

1. All-wire clothes hanger
2. 30 sq. in. of cheesecloth (old curtain or some other cloth of similar texture). The material needs to be porous enough so that air will readily pass through, yet tight enough so insects cannot escape.
3. An old broom handle or similar wood



4. Brace and bit and 3/16″ drill
5. Needle with a large eye
6. About nine feet of light string or heavy thread
7. Hammer, two or three roofing nails, pair of pliers, wire cutters, scissors

Procedure:

Bend the base of the clothes hanger until it is circular. Cut off the hook just above the wire twist. Sew the cheesecloth or curtain material around the loop of the clothes hanger. The open edge and bottom can now be sewn so as to make the sack complete. A variation is to cut the material so that it tapers at the base like a commercial net. *Remember,* the material from a sugar, flour, or other sack is not satisfactory for nets because it is too closely woven and air will not pass through readily. Also, it is next to impossible to see whether or not there is an insect in the net. The collector needs to see the insect through the net in order to get the killing jar to the insect.

Drill a 3/16″ hole about two inches deep into the cut (flat) end of the broom handle. A center point for drilling can be made by starting a nail and then removing it.

Screw the twisted end of the hanger loop into the drilled broom handle. Force the wire in, right up to the loop. If the loop is loose or becomes loose with use, one or two nails can be hammered into the drill hole beside the hanger wire.

Killing Jar

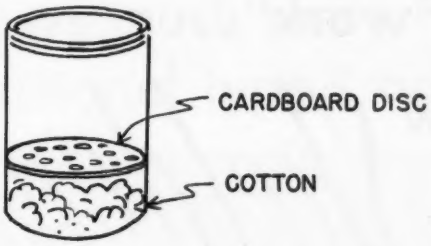
Materials:

1. A jar about three or four inches high and of same diameter that has the sides straight down from the mouth, such as a peanut butter jar
2. Enough cotton or other absorbent material to make an inch layer on the bottom of the jar
3. A piece of thin cardboard from a cereal box with the same diameter as the bottle
4. Killing fluid such as carbon tetrachloride, Carbona, or cleaning fluids. *Use fluids that will not burn.*

Procedure:

Make a layer of the cotton on the bottom of the jar about one inch deep. Cut out a piece of thin cardboard to go down over the cotton. This is to serve as a floor so that insects will not become snarled in the cotton. Punch several holes in the

cardboard so that fumes can pass through from the cotton.



Sprinkle a teaspoonful of the killing solution over the cotton. Insert the disc of cardboard and force it down against the cotton; then screw on an air-tight lid. *It is best to charge killing jars out of doors.*

Do not leave too many dead insects in the killing jar because the live ones will damage the wings and bodies of the dead insects.

A small vial of isopropyl alcohol (rubbing alcohol) is best for killing beetles. Drop them into the alcohol until you are ready to mount them. The fumes of a killing jar will not suffocate beetles effectively.

Pinning and Drying Board

A strawberry case or other similar case is a good source of wood for building pinning boards.

Two pieces of wood 1 x 3 x 8 inches are used for the ends. An end of a berry case sawed in half is just right. The slats from the bottom or sides of the case are good pinning boards.

Mounting pins can be purchased from biological supply houses or corsage pins are suitable. Small, straight pins can be used for spreading the wings.

When the butterfly or moth is dead, place a mounting pin through the center of the thorax. This is turn is stuck into the cardboard strip so that the insect's body is between the pinning boards and the wings are level with them. Along the leading (front) edge of each pair of wings is a heavy vein. Using a straight pin, place it behind the vein of the wing and stretch the wing to the desired display position. This can be done with the remaining three wings.

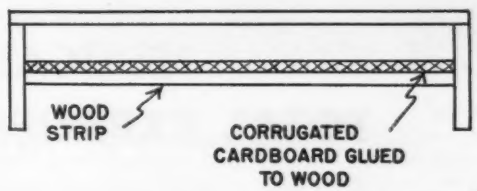
To hold the wings flat while drying, a narrow strip of glass or cardboard can be pinned down over the stretched wings.

After the insect has dried out—a day or two—the wings will hold their open position. From now on the insect should be handled *only* by the mounting pin through the thorax. This will avoid breaking the fragile wings.

The small straight pins can be removed from the wings and the insect lifted off the drying board by means of the mounting pin and placed in a mounting case. Put the insect's name and other pertinent data on a small piece of paper; then stick the mounting pin through the slip so that the paper is up near the insect's body.

Space at "A" in drawing below needs to be wide enough for an insect's body to fit between pinning boards. The space can taper so that various sizes of insects can be pinned on the same board.

Corrugated cardboard is glued to the wood strip as shown in the following side-view drawing. The mounting pin is stuck into this strip of cardboard. Soft wood such as balsam will serve as well as cardboard.



Insect Mounting Case

An inexpensive mounting case for a small insect collection is a cigar box. A piece of cellophane, clear plastic, or glass can be attached under the lid so that the collection can be observed without letting dust or dermestids into the box.

All cases should have a small pill box or other container in one corner where mothballs, paradichlorobenzene crystals, or other similar substance can be placed so that dermestids will not enter and lay eggs in the collected specimens.

Larger mounting cases can be made by purchasing pieces of celotex and cutting them to the size desired. White celotex gives an effective and clean background for mounted specimens. The sides can be made from the ends of a berry case, or lumber 1 x 3 inches is excellent. School shops, lumber stores, or home workshops are the places to rabbet a groove for the glass top to fit in. The glass can be held with small brads.

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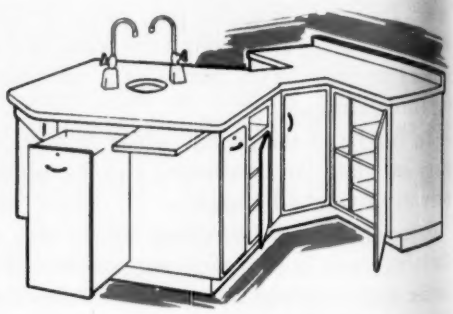

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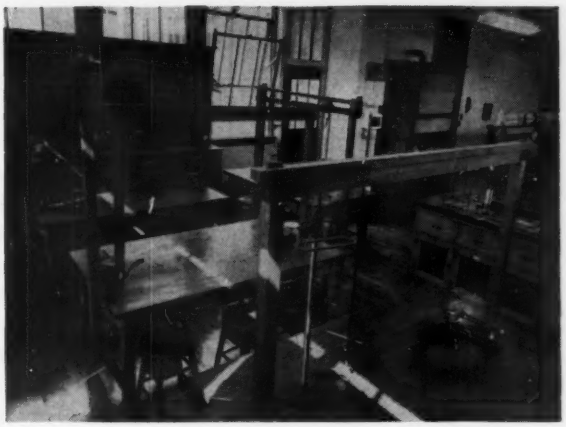

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CAMERA CRAFT

Make Your Own Demonstration Model

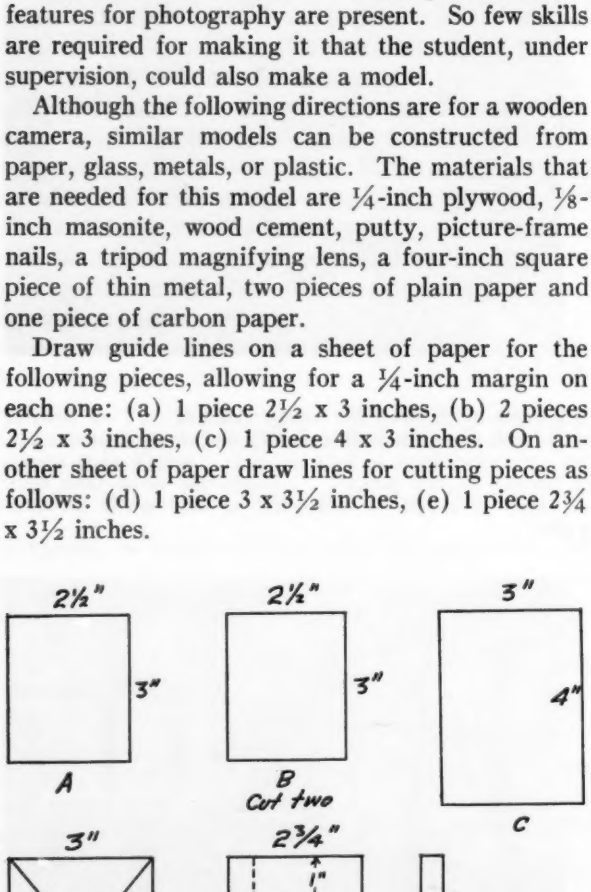
By JOAN CASSAVANT
Cornell University, Ithaca, New York

DEMONSTRATIONS facilitate a student's comprehension of principles. This three-dimensional camera-model is of value to the teacher for showing the functions of a camera, and for experimental picture taking.

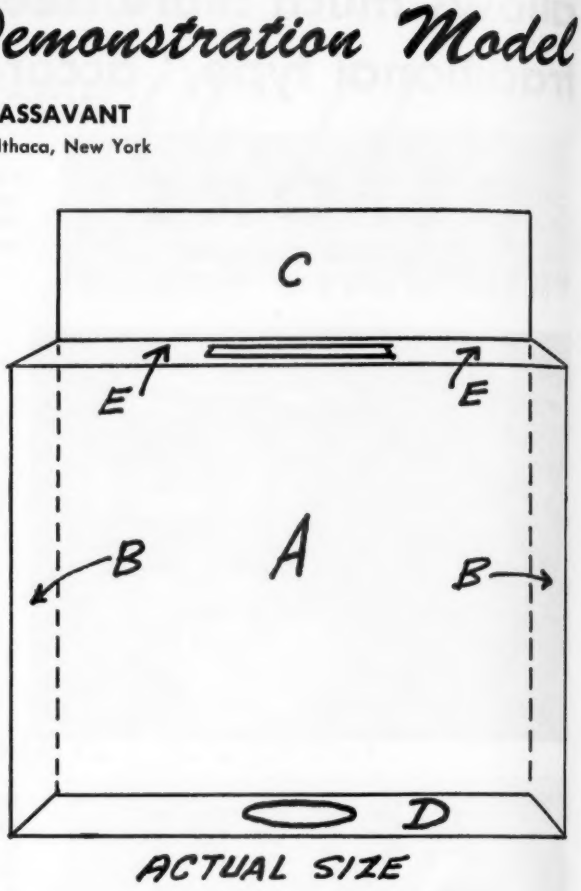
The camera is modified so that only the essential features for photography are present. So few skills are required for making it that the student, under supervision, could also make a model.

Although the following directions are for a wooden camera, similar models can be constructed from paper, glass, metals, or plastic. The materials that are needed for this model are ¼-inch plywood, ⅛-inch masonite, wood cement, putty, picture-frame nails, a tripod magnifying lens, a four-inch square piece of thin metal, two pieces of plain paper and one piece of carbon paper.

Draw guide lines on a sheet of paper for the following pieces, allowing for a ¼-inch margin on each one: (a) 1 piece 2½ x 3 inches, (b) 2 pieces 2½ x 3 inches, (c) 1 piece 4 x 3 inches. On another sheet of paper draw lines for cutting pieces as follows: (d) 1 piece 3 x 3½ inches, (e) 1 piece 2¾ x 3½ inches.



Use a carbon paper to transfer the guide lines for pieces (a), (b), and (c) to ¼-inch plywood. Similarly, transfer the guides lines for pieces (d) and (e) to ⅛-inch masonite board.



Using a jig saw, cut out the pieces just outside the guide lines. Finish them to the line on a sanding wheel. Assemble the pieces without fastening and resand the wooden pieces as necessary to form well-fitted sides of a box.

Find the center of piece (d) by ruling intersecting, diagonal lines. Around this center draw a circle, 1 and 7/16 inches in diameter. On piece (e) draw an opening 1 x 1½ inches so that this opening will be 1 inch from each end and 1 inch from one side. Using a jig saw or a coping saw, cut out these openings just inside the lines. With a file, complete the cut to exact dimensions. It may be necessary to finish these openings with a sanding wheel.

Now assemble the camera, using nails pounded only part way in. If filling or sanding is needed to make a good fit, carry this through and then fasten all the nails so that they extend slightly below the

surface of the wood. Put putty in the nailholes and cracks.

Remove the legs from a tripod magnifier and mount the rim in the round hole of piece (d). Use wood cement to fasten in the lens.

Use cement to mount a narrow, straight piece of masonite on piece (e) so that it will run $\frac{3}{16}$ inch from the hole and adjacent to the supporting side (c) for the box.

Make two cuts in the opposite edges of the piece holding the lens of the magnifier so that a rubber band, stretched across and fastened in these cuts, may be used to hold round discs over the front of the lens.

Prepare two round discs to fit over the lens. In the center of one of them drill a hole $\frac{1}{4}$ inch in diameter. In the center of the other drill a hole $\frac{1}{32}$ inch in diameter. These discs are used interchangeably to let in varying amounts of light.

The teaching model is a simple copying camera for making 2 x 2 lantern slides. Like any camera, this one must be experimented with to see how much exposure is needed to produce a pleasing picture. However, there are some general directions that may help the cameraman to prepare the camera for taking pictures.

In a dark room cut a piece of film $1\frac{1}{2}$ x 2 inches to fit over the hole on side (e). Cut a piece of felt or cardboard slightly larger than the film piece. Place the film over the hole (e) and the felt over the film. Tape the cover piece to the box so that the film is light-tight.

Put one of the discs in place and cover it with a piece of felt or your hand. The felt does not need to be taped. Now the camera is ready to be taken out of the dark room. When the camera is in position to take a picture, remove the cover from the lens and expose the film for the desired length of time. Recover the lens until the camera is again in the dark room. Now the film is ready to be developed and can be removed from the box.

Other means for taking pictures are left up to the operator's initiative. With proper stimulus, the students can gain both educational and avocational values from making and operating this model.

Junior Scientist Magnetism Kit. Providing materials needed to perform 100 science activities, this kit, for use by two or three children from the 4th to the 8th grades, is a new product to stimulate science interest. (Order from Science Research Associates, 500 Fifth Ave., New York 36, N. Y. The kit is $2.60; carton of eight, $18.80; an accompanying workbook-form manual is 48¢.)

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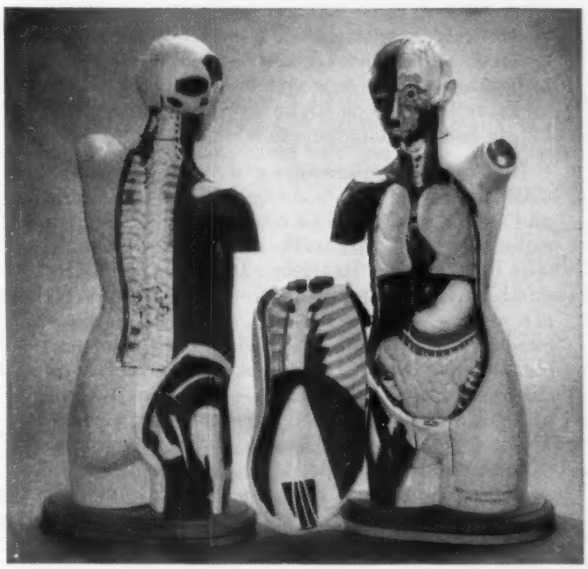

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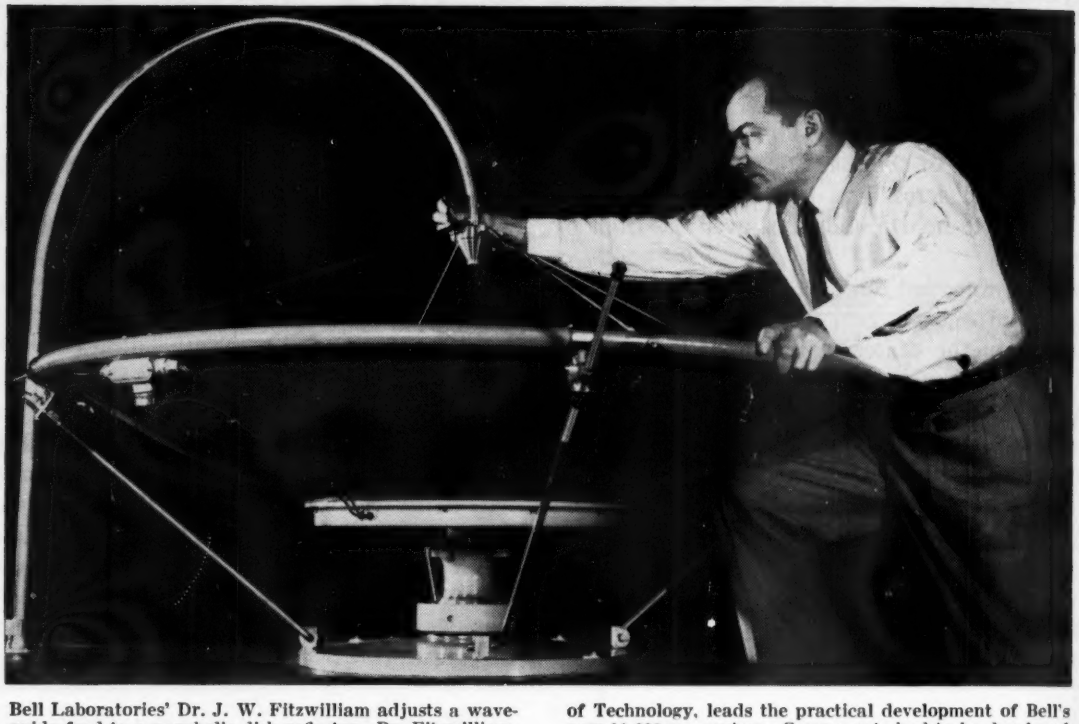

Bell Laboratories' Dr. J. W. Fitzwilliam adjusts a waveguide feed to a parabolic dish reflector. Dr. Fitzwilliam, who has a Ph.D. in physics from Massachusetts Institute of Technology, leads the practical development of Bell's new 11,000-mc. system. Components had to be developed to operate in a frequency band not previously utilized.

The giant microwave highway that carries your TV programs along with telephone conversations from coast to coast has a versatile new partner—an entirely new microwave system which was created, and is now being developed, at Bell Laboratories. The new system operates at 11,000 megacycles—a much higher frequency than ever before used in telephone service.

Bell's present microwave systems—operating at 4000 megacycles—were designed for heavy traffic and long distances. The new system is designed especially for lighter traffic and shorter distances—up to 200 miles. Its traffic capacity is extremely flexible. Depending on traffic needs, the system can provide only one one-way or as many as three two-way broadband channels. Each two-way channel can carry 200 telephone conversations simultaneously or one television program in color or black and white in each direction along a route. The new system, which is already being operated experimentally, will be particularly valuable in providing additional telephone service and TV programs for cities in remote areas.

This is another example of how research and development work at Bell Laboratories help the Bell Telephone System to serve you better.

Mr. L. C. Tillotson, who originated the new system, adjusts the klystron-isolator combination which made the system feasible. Mr. Tillotson, an M.S. from the University of Missouri, heads research in microwave applications.

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Throw the Switch!

By LYNN E. FRAZIER

Menlo Avenue Elementary School, Los Angeles, California

WE AND THE CHILDREN WE TEACH, throw dozens of switches every day, and they work! But how do they work? What makes the electric light turn on? The toast pop up? The coffee bubble?

Hazy concepts of our everyday physical environment are an unnecessary handicap with which to live. We think we live in a complicated scientific age today. Our voices and pictures are transmitted around the world. Our planes and missiles have traveled at fantastic speeds. Electricity is a vital factor in each phase of these monumental human accomplishments. Indications are that the growing generations will find themselves in a world infinitely more complex than we now have.

Perhaps we are waiting too long to introduce the more basic scientific concepts to pupils. Perhaps we unnecessarily delay the laying down of an adequate foundation upon which to build more advanced understandings. Science is a subject which acquaints children with their physical environment and helps them approach problem-solving situations with method and objectivity.

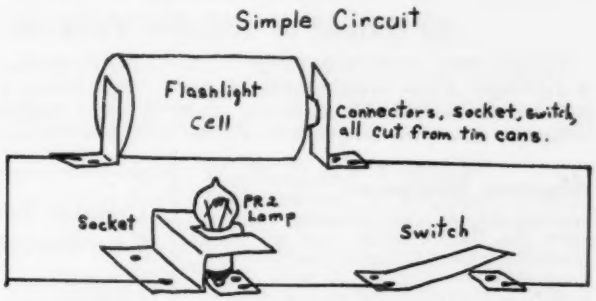
Electricity, for example, is a most fascinating scientific phenomenon to any elementary age child. Give a six-year-old a flashlight and observe his joyous investigation of its parts. Give a sixth-grader a plan for a small electric motor or a crystal radio set, and watch the enthusiasm with which he brings the plans to reality.

There are experiments in electricity suited for any grade level or mental age. The teacher will find new assurance in the way children jump at the opportunity to try their hand.

Following are a few projects that will add meaning and interest to the study of electricity. Turn a class to work and when the projects are completed just "throw the switch!" Science will have achieved a new spark—and maybe a new scientist.

This project is ideal for beginning a study of electrical circuits. It uses only the tin can connectors, necessitates a minimum of expenditure, and it can be mounted easily on a block of wood about 4″ x 5″.

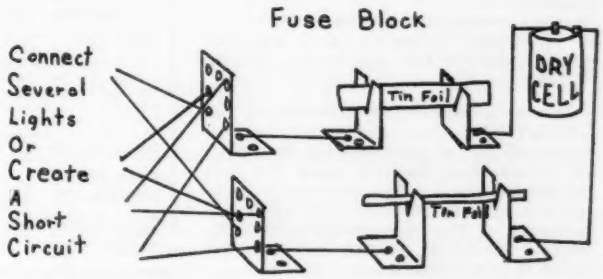
Directions: Secure connectors in their proper places with one nail. Drive a second nail about one third of the way into the wood. Strip insulation from ends of three wires, using a small patch of sandpaper or a rough edge of a piece of tin. Wrap the stripped end of each wire three or four times around the partially-driven nail and finish driving the nail. Connection is complete. Do likewise to the other connections and circuit is complete.



Uses: As rich motivation for ruler study; as signal lights during quizzes, panel activities, etc.; learning of codes; practical lesson in following directions carefully.

What Is Learned: Whole number and fractional values of linear measure; value of electrical insulation; principle of home circuits; continuity of contact through all appliances; construction of a 1½-volt dry cell; operational function of a socket and of a switch; the knowledge that electricty in low voltage is harmless to the human body.

Materials: Wood base; six 1½″ x ½″ tin can connectors; No. 6 dry cell; eight small nails or tacks; two strips of aluminum foil and scissors with which to cut them.



How to Make: Vary the basic connectors by making several nail holes in two of them and make very narrow "v" cuts in the ends of the other four. Make connections as shown in diagram. Place wide and narrow aluminum strips in the "v" cuts as shown. The large strip simulates a large amperage fuse, e.g.

You Can Depend on the GENATRON

● *The MODERN Electrostatic Generator*

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendous high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

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Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal*. The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

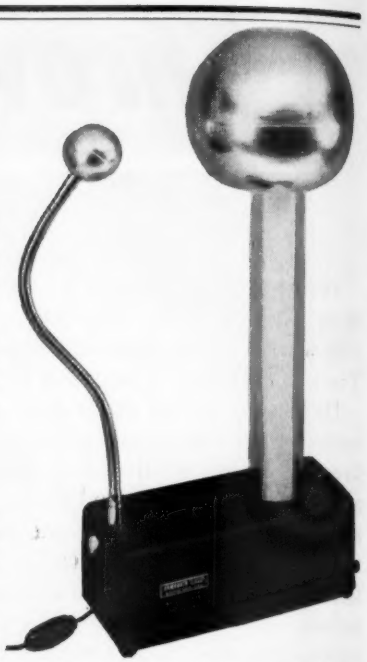
DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



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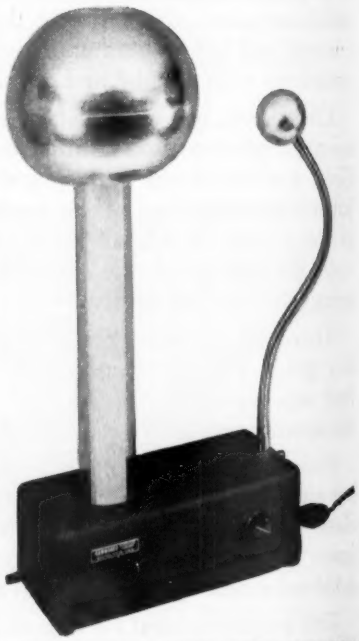

GENATRON, WITH SPEED CONTROL
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No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708 **$3.00**

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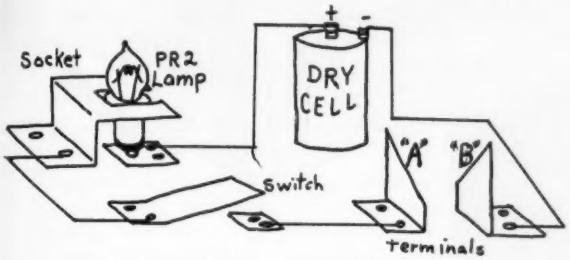
30 amp, and the narrow strip simulates a lower amperage fuse, e.g. 15 amp as in most home circuits. As additional appliances are added, or if a short circuit is made, the narrow strip will melt, breaking the circuit until the overload has been corrected and a new strip has been installed.

What Is Learned: First, we learn how a fuse works. Second, and more important, we learn that a fuse is an electrical safety switch, a signal that there is danger to our house and appliances. We should learn that small amperage fuses give us greater protection and that when a fuse blows out we should rejoice rather than grumble.

Materials: Basic tin can connectors, two of which are modified by angle cuts on top; base, wire, lamp, No. 6 dry cell.

Conductivity Tester



How to Make: This is a simple lamp and switch circuit with the addition of the contacts A and B.

How to Use: Lay material to be tested across angled contacts A and B and close switch. If lamp lights, circuit has been completed proving that the material being tested is a conductor of electricity. If lamp does not light, the material being tested is an insulator of electricity. A better term is "non-conductor."

What Is Learned: Some materials can carry electricity. They are called conductors. Some materials cannot carry electricity. They are called non-conductors. Some non-conductors become conductors when they are wet.

American Education Week will be observed this year from November 11th through 17th, with the general theme of *Schools for a Strong America.* An annual event since 1921 when it was established jointly by the National Education Association and the American Legion, American Education Week is also sponsored this year by the U. S. Office of Education and the National Congress of Parents and Teachers. Posters, buttons, planning helps, publicity mats, and other materials can be purchased at cost from NEA's Division of Press and Radio Relations, 1201 Sixteenth St., N.W., Washington 6, D. C.

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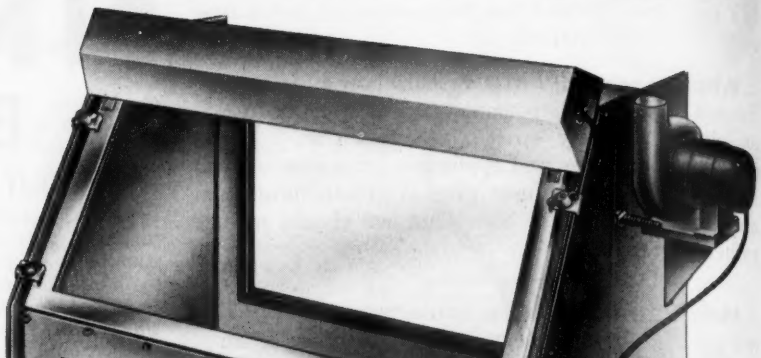

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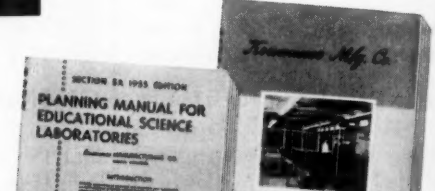

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NSTA Activities

Staff

Three new appointments and one re-assignment of responsibilities constitute recent major changes in NSTA's staff.

Glenn E. Warneking has been named Executive Assistant. He comes to this position from that of teacher of physical science and mathematics in the Ann Arbor, Michigan, Senior High School. Prior to teaching in Ann Arbor during 1955-56, Mr. Warneking taught for five years in the Blair, Nebraska, High School. He has his Master's degree from the University of Nebraska. The Warnekings—Glenn, Dorothy, and Dawn (9 mos.)—have established residence in Wheaton, Maryland.

Miss Jerry Askwith is the new Managing Editor of *The Science Teacher* and will serve as editor for other NSTA publication projects. A graduate of the School of Journalism of Syracuse University, Syracuse, New York, she has had extensive editorial experience in New York City and in Washington with various government agencies. Her work has included writing and serving as story editor for a TV network series. Miss Askwith joined NSTA August 1.

The addition of Miss Askwith has enabled us to release Mrs. Mary (Batiste) Murchison from *TST* responsibilities. She is now serving full time as Administrative Assistant in charge of office coordination, liaison with the Board of Directors and committees, and catalyst for many on-going NSTA activities.

Miss E. Louise Lyons of Steubenville, Ohio, joined the NSTA staff October 1 as Membership Secretary. She succeeds Miss Paula Robertson who resigned to undertake a two-year assignment with the U. S. Army recreation program in Europe. Miss Lyons has just retired as teacher of chemistry in the Steubenville High School and coordinator of science in the Steubenville public schools. She has served as NSTA director for Ohio and was chairman of the Cincinnati (1955) national convention.

STAR Awards

NSTA members are reminded (and to remind their colleagues) of the 1956 program of *STAR* Awards—that this is your chance to win a $200 cash award or a three-day, all-expense trip to Washington, D. C. Plan, classroom-test, and write up a science teaching idea; submit two copies of your report not later than December 21, 1956. (See September issue of *TST*, page 251, or write NSTA for information.) Awards will be announced and presented at the NSTA convention in Cleveland, Ohio, next March 20-23.

Membership

Amazing, almost, is the fact that during the "lean" summer months, NSTA membership increased by more than 700. With an official count of 9018 as of the close of the fiscal year last May 31, the mailing roll for September *TST* exceeded 9700, and is over the 10,000 mark as this issue goes to press.

Much credit for the sharp increase in NSTA membership goes to Martin Thames of Bemidji, Minnesota. He served as national membership chairman for five years, relinquishing this post last July 1 to Elra Palmer of Baltimore, Maryland, who accepted a three-year appointment. Membership was under 5000 when Mr. Thames began his nation-wide efforts with state and area directors in 1951. Official recognition and appreciation for this service was extended to Mr. Thames by the Board of Directors in their Corvallis meeting last summer.

An encouraging feature of membership growth is the large number of sustaining members. These members provide an extra two dollars in support of NSTA endeavors; they receive in return such "extras" as we are able to procure from time to time. During 1955-56, these extra services included a full-color filmstrip, a commercially published book, and a kit of teaching aids about aluminum. Why don't you consider changing to "sustaining" when you renew for 1957?

Biology Committee

In cooperation with the Division of Biology and Agriculture of the National Research Council, NSTA has named three representatives to serve on a joint committee to develop recommendations for a modern course in high school biology. They are: Florence Gardner, West Orange, New Jersey, High School; William Jones, Handley High School, Winchester, Virginia; and Joseph McMenamin, Oak Park and River Forest, Illinois, High School. NABT has also named three members of the committee which will be chaired by Dr. William Chadwick of Peabody College for Teachers, Nashville, Tennessee. The work of this committee will tie in with a special work-conference in biology being planned for Michigan State University next summer under the leadership of Dr. Chester Lawson, chairman of MSU's Department of Natural Sciences.

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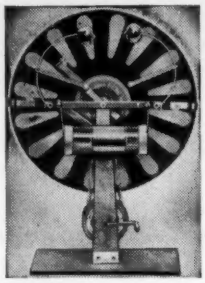

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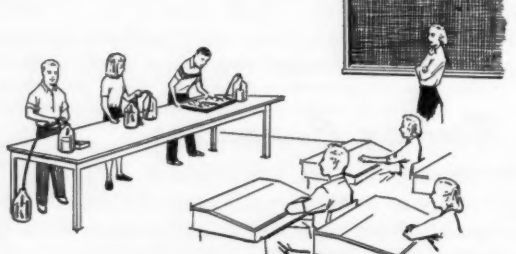

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FSA Activities

Roster of Sponsors

Additional contributors to the fund for the Future Scientists of America Foundation since the listing in September's *TST* include the following:

The Bell Foundation, Inc.
Fluor Corporation, Ltd.
Sanborn Company
United Aircraft Corporation

To date for 1956, the Foundation has received $38,000 dedicated to the support of special projects and $34,375 in support of the general program of FSAF. The roster now includes 65 sponsors.

Student Publication

Reactions to the four exploratory issues of *Tomorrow's Scientists* have been encouraging—sufficiently so that a sum of money has been appropriated by FSAF to enable the publication to be carried through at least three more issues this fall. Issues are being planned for October, November, and December. At least 5000 subscriptions at 50 cents each must be obtained, however, to assure continued publication. This minimum acceptance by teachers and students will guarantee issues at no additional subscription cost in February, March, and April and possibly January or May.

Arrangements have been made with science teachers from the Prince Georges County, Maryland, school system to "carry the ball" on the production of *Tomorrow's Scientists.* William Gruver, biology teacher, and Dale Gerster, teacher of physics and chemistry, will serve as co-editors. They will have the assistance of an advisory committee of other science teachers in the system and of a number of students from the junior and senior high schools. Printing and distribution will be handled by the NSTA office staff.

Science teachers and science students are urged to cooperate in making this undertaking a success. The first way you can help is by entering a number of subscriptions from your students. Then when you begin receiving the publication, let us have your suggestions, criticisms, and contributions for future issues. Send your communications to the NSTA headquarters and they will be passed on to the co-editors.

Student Awards

It takes more than talk and printed, textual material to help students really understand what is meant by "scientific methods." Doing science projects helps. They enable youngsters to experience the ways in which scientists work and the satisfactions (and disappointments) that accompany scientific endeavors.

The Science Achievement Awards for Students are designed to stimulate students in such activities and to aid teachers who believe that project teaching *is* important. Some 5000 students participated in the program last year and 988 were given awards and recognition. Now is the time to get projects under way for entry in the 1957, Sixth Annual Program.

Project ideas can come from many sources: from printed lists and publications; from a class laboratory exercise that "didn't work;" from ideas gained on field trips or industrial visits; from reading technical and semi-technical journals and reports; from students' questions that begin, "I wonder . . ." Any activity that parallels or is similar to what scientists do can constitute a project.

Since entrants in SAA *do not* send in their projects, the writing of reports on their projects is an extremely important step. Scientists, too, write reports because they realize that no discovery, invention, or new idea can reach its full value until it has been explained or communicated to other interested persons.

Students should be reminded of the following important rules for the Science Achievement Awards program:

1. The deadline date is March 15, 1957. Entries should be postmarked *by this date for mailing to regional chairmen.*

2. Entry in the program gives NSTA and FSAF publication rights for use of the report in furtherance of the program.

3. Entries cannot be returned to students.

4. Entries should be the work of individual students; group entries are not accepted.

Summer Conferences

The FSAF design for summer conferences for science teachers is gaining in favor, among teachers and with sponsoring groups. Close on the heels of the successful 1956 West Coast Conference (sponsored by Crown Zellerbach Foundation) and the 1956 Conference for Wisconsin High School Chemistry Teachers (sponsored by the Marathon Corporation), word has been received that the West Virginia Pulp and Paper Company will cooperate with FSAF in sponsoring a special conference next summer. Details are still to be worked out by an Advisory Committee, but it is shaping up as an invitational conference held at and

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with the cooperation of the University of Maryland. Science teachers are urged to let us have expressions of advice and "this is what we want" suggestions.

Keys to Careers

The fourth annual edition of FSAF's career guidance bibliography is just off the press. Retitled, it is now called *Encouraging Future Scientists: Keys to Careers,* which was selected as more descriptive than the previous title, *Encouraging Future Scientists: Materials and Services Available.*

Because of the wealth of new material which came to the editors' attention, the 1956-57 edition of the booklet has 36 pages, a jump of 12 pages from last year's bibliography. The listing of Career Guidance Booklets and Fliers, now indexed by career fields, totals more than 150 items. Among other sections are: Career Guidance Films; Where to Get Scholarship Data; Award, Summer, and Other Programs for Students; Award, Fellowship, and Other Programs for Teachers; The Field Trip; The Career Conference; Agencies Which Can Help; and Where to Look for More Help. Also included is a complete roster of FSAF sponsors as of September 15, 1956.

The booklet's handsome cover—red and white on a grey-blue background—was specially designed for *Keys to Careers.* Copies may be obtained from NSTA headquarters. Single copies are free; orders for additional copies will be filled at cost.

SELECTED SCIENCE BOOKS

Among the Best for Projects and Class and Club Activities

ELEMENTARY AND JUNIOR HIGH SCIENCE

All About the Wonders of Chemistry—Freeman.....$1.95
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ROSS—continued from page 281.

then a study of the undergraduate college student alone to determine factors influencing him to go into science may yield biased results, since the important effects of very early experiences will probably not be emphasized by the undergraduate.

Like Wilson we also found that the altruistic motive of helping society is a motivating factor. However, the factor of greatest importance to the biological science student is the intellectual one of acquiring knowledge for its own sake. Wilson also reports this, but it does not appear to be as important with his group as with ours. Wilson reports that financial goals are often named as the second reason why the social science major wished to work in science. We did not find any cases where this was listed, and only one case where the desire to obtain community status was stressed. The discrepancy in terms of financial goals may be a function of differences between the two samples. The majority of our students come from economically well-to-do homes and may not have considered financial remuneration as being important. In fact, these students (or their families) had to pay their own transportation to the Laboratory as well as pay for their room and board for the ten weeks. Wilson's students were applying for financial grants to assist them in conducting research during the summer while our students were supported by their families during the summer.

When the fields of concurrent interest of the two groups are compared, certain similarities are again noted. Wilson found that the humanities ranked highest with the social science major, followed by physical and natural sciences (grouped together), then art, and finally mathematics (seven per cent of the group indicated an interest in mathematics). We found that humanities, writing, and music rank highest (though there were not many responses here) with the other categories having relatively few responses.

Many of our students indicated that they have already made career decisions. Twelve of them have indicated an interest in research, nine wished to go into medicine, and one wanted to be a medical missionary. On the other hand, the budding social scientist does not make his decision to go into social science until relatively late in his academic career (8, 9). The reason for this discrepancy is probably the one that Wilson has given, e.g., that medicine and biological research are fields well-known to the high school student, while a familiarity with the social sciences does not come until the college years.

Perhaps the best way to convey the flavor and importance to some of the factors we have discussed, as well as the maturity of the students, is by presenting quotes from several of the papers.

"In the eighth grade, I was at last able to take a formal course in general science."

"In my sophomore year (in high school), I began working on a project concerned with the effect of colchicine on fruit flies. . . . This project also gave me opportunity to do library research on the results of the application of colchicine to patients suffering from cancer and gout."

"I like to explore new things, see why they do just what they are doing, etc. It is rewarding if one can contribute a small portion of something new in his field to science and in the future years I hope to attempt this feat."

"My interest in science was further helped by a grade school science teacher who let me prepare the classes' science demonstrations. . . . In high school I had a biology teacher who was a real great guy and took some interest in me."

"Last summer probably marked the greatest scientific opportunity of my life until the present time. . . . The most valuable thing I brought home from the Pre-Collegiate Research Training Program of 1954 was an increased knowledge of certain biological concepts and the mastery of certain basic techniques. Undoubtedly if it wasn't for the training I received last summer, I wouldn't have been as successful as I was in the Annual Westinghouse Science Talent Search."

"As for what I hope to derive from this profession (research), I can't say that I am really certain. Probably, like the famous mountaineer said when asked why he climbed mountains, 'Just because they are there.' In the same manner, I want to do research because there are things which, as of yet, are unexplained."

"As early as the second grade I can remember working on scientific demonstrations (simple as they were) and deriving much pleasure from reading various books."

Conclusions

In trying to evaluate these results we believe that the following conclusions are reasonable within the limitations of the sample and the method of analysis.

1. Superior high school science students are influenced *early* in life by experiences with people who stimulate the development of scientific interest.
2. There is a wide array of experiences which can foster interest in science.
3. The contributions of grade school teachers

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and high school teachers are perhaps the most impressive experiences on the part of the students in developing interests in science.

4. An aspect of motivation which is of major importance to these students in regard to science is the intellectual one of "acquiring knowledge, self-satisfaction, and satisfying curiosity."

5. Career decisions with the major interests being in research and medicine are made by some students at a very early age.

6. There seem to be several similar patterns between the undergraduate social science students and the high school students interestd in biological research. These include: influence of parents (primarily fathers) and high school teachers, motivations of acquiring knowledge and making a useful contribution to society, and an interest in humanities usually paired with a relatively low interest in mathematics.

Though our approach is admittedly a primitive one, the implications of the findings appear to be significant especially when coupled with Wilson's analysis of undergraduate social science majors. The possibility of constellations of factors common to scientists in many diverse areas should not be overlooked. We believe that more extensive and sophisticated studies of the phenomenology of the development of interest in science together with the measurement of critical psychological variables is clearly indicated. We also believe that such studies are not only valuable but are also feasible, and should be part of the major national effort in this area.

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Footnotes

(a) Test performance of these students during the first week of the program may be summarized briefly. The standard score mean for the group on the *Nelson Biology Test* (7) was 135.8. This score has a percentile equivalent of 99 for a high school population of 4993 students who had one year of high school biology. The group mean (raw score) on the *Stanford Scientific Aptitude Test* (13) was 110.5, which is approximately .2 standard deviations above the mean of unselected Stanford University freshmen. On the Allport-Vernon *Study of Values* (1) the group scored "high" for theoretical values, "low" for economic values, and "average" for aesthetic, social, political, and religious values. On the *Bell Adjustment Inventory* (2) the group mean was "good" for emotional adjustment, "average" for home adjustment and health adjustment, and "aggressive" for social adjustment. In terms of these tests, the group was superior both intellectually and in its knowledge of biology; and it scored high in theoretical interests and showed good overall personal adjustment. Other information indicates that the students were superior academically, and that they were practical achievers with relatively high levels of aspiration for individual accomplishments. Approximately one-third of the students were winners of science talent contests. All students anticipated attending college immediately upon completing high school. They were generally products of socially acceptable and economically comfortable home environments.

(b) This request is almost an exact copy of one required by the Social Science Research Council from college juniors who are applicants for undergraduate research stipends. See Wilson's discussion of the undergraduate social scientist (9).

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SMELTZ—continued from page 285.

and 75 girls of the study were not significantly different at the one per cent level.

The critical ratio between the difference of percentages of gain of factual and theoretical information retained was 1.99 at the five per cent level. As all other differences of percentage were less, no other critical ratios were calculated.

The 180 chemistry pupils were found to be an average group when compared with the national end-of-year percentiles of the test.

The means of the first test scores of pupils enrolled in chemistry and of those not enrolled were not significantly different. However, the means of the scores of the last test were significantly different. The critical ratio was 14.74.

Conclusions

1. Pupils who had chemistry during the eleventh grade retained approximately 68 per cent of the information achieved during the course one year following the completion of the course.
2. The amount of chemistry retained was more closely related to achievement than to intelligence; however, intelligence was a factor. Intelligence was also related to achievement.
3. Pupils who planned to attend college retained more chemistry than pupils who did not plan to attend college.
4. Pupils who expressed a preference for chemistry among other subjects retained more than pupils who expressed preference for other subjects.
5. Pupils enrolled in physics retained more chemistry than pupils not enrolled in physics.
6. The sex of the pupils was not a factor in the amount of chemistry retained.
7. There was no significant difference in the types of learnings retained.

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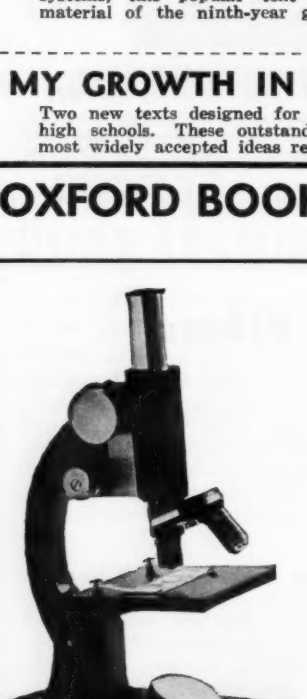

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DuBRIDGE—continued from page 276.

mathematics that really arrest a youngster's imagination, challenge his curiosity, and develop his quantitative reasoning would be the greatest project that a teachers' group could undertake.

The second illusion that must be eliminated is that mathematics can be taught by teachers who don't know any math—or are only a chapter ahead of the student. As long as teachers of math must take 16 hours of education and only three hours of math, mathematics will be badly taught. For it is a subject which becomes really alive only with years of study and can be conveyed in simple and exciting ways to students only by those who have themselves caught its true spirit.

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For if we are cheating our children of the opportunity of enjoying the adventures in science, we are also cheating our country of the benefits of profiting and prospering from the talents of her people.

EDITOR'S COLUMN—continued from page 269.

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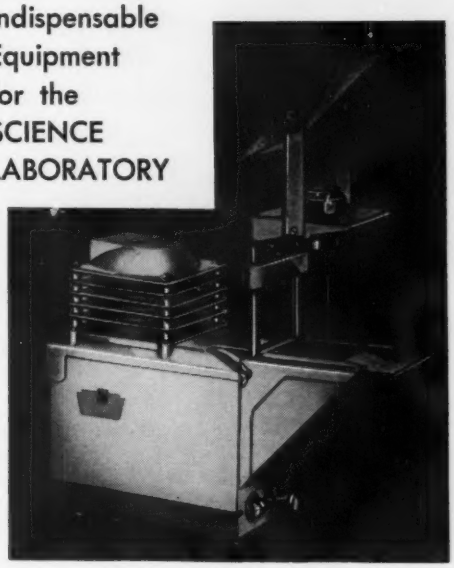

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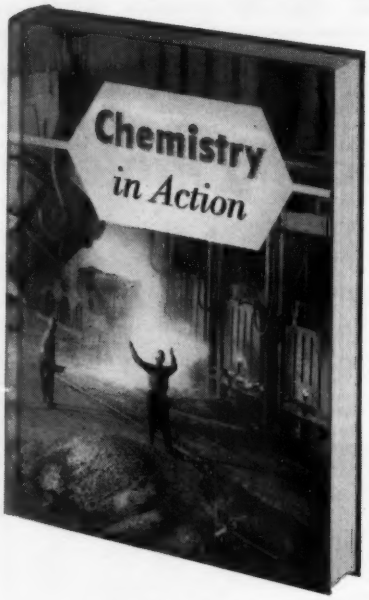

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Professor Pearl's latest contribution to the reading public contains, as his preface says, "the most recent accurate knowledge about the entire range of the mineral kingdom." It is intended for the general reader, and is a very sympathetic and comprehensive treatment of the subject written in true handbook style.

This interesting book will please the amateur collector with its information on how to identify rocks and minerals, how to classify and display them, and where to look for them. It will also please the teacher of general science because it gives not only the origins of the various types and their chemical compositions, but also their current industrial uses. Gems, meteorites, and oddities in the mineral kingdom are discussed, as well as crystal systems and fluorescent, atomic, and artificial minerals.

The book has 12 pages of color illustrations as well as photographs and line drawings, an ample glossary, and a useful annotated list of books and magazines for further study.

SISTER MARY CASIMIR
Camden Catholic High School
Camden, New Jersey

GENETICS IS EASY. Philip Goldstein. 238p. $4.00. Lantern Press, Inc., New York. 1955 (Second Edition).

Within the context of this book, the author has presented clearly, interestingly, and precisely the technical aspects of the reproduction characteristics in plant and animal life. The layman with an average education will find this material both interesting and informative; yet those needing accurate information will find it instructive and technical. The biology student will find the concluding bibliography and index very helpful.

The chapters are short, to the point, and effectively illustrated with labeled diagrams. Genetics has been cleverly presented in the context of this book, which is suitable for use as a high school or supplementary text.

MRS. CHARLOTTE BABCOCK
Albany Public Schools
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EXPLORING MODERN SCIENCE, Book Seven, ENJOYING MODERN SCIENCE, Book Eight, and USING MODERN SCIENCE, Book Nine. Victor C. Smith and W. E. Jones. (Book Seven: 335p., $3.12; Book Eight: 466p., $3.32; Book Nine: 654p., $3.96.) J. B. Lippincott Co., Chicago. 1956.

These textbooks are second editions in the *Science for Modern Living Series,* based in part upon the earlier books by Smith and Trafton. According to the authors, this series ". . . develops for the pupil an understanding of his whole environment in terms of underlying scientific principles and of their functional application to problems of everyday living."

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CLARE F. SMITH
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ENJOYING HEALTH. Evelyn G. Jones. 434p. J. B. Lippincott Co., Chicago. 1956 (Second Edition).

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EXPLORING SCIENCE, Book Three, and EXPLORING SCIENCE, Book Four. Walter A. Thurber. (Book Three: 192p., $2.00; Book Four: 224p., $2.16.) Allyn and Bacon, Inc., New York. 1955.

In these two volumes of a six-year series of science texts, great emphasis is placed on first-hand experience and science activities for third and fourth grade children. As quoted in the Introduction, "the study of things—not ideas," is the philosophical backbone of these books. This represents a useful departure from some other texts for these grades which stress and contain the development of science facts and concepts in much greater detail. But such varying degrees of emphasis only indicate again that the textual needs of any subject and of the teaching-learning process are too comprehensive to be met completely by any one approach to those needs.

The "how-to-do-it" approach, as the author calls it, is well organized around basic science areas within the experience of third and fourth graders. For example, "Making Things Move," one of the 12 topics in Book Three, deals with Energy in Toys, Storing and Using Energy, and several toy-making projects. Further development of this area occurs in "Balancing Forces," of Book Four, which is about levers, weights, and their everyday use and application. Similar care and organization are evident in the sequential development of most of the topics from grade to grade.

Each teacher's edition contains detailed suggestions for teaching each unit along very practical lines, plus valuable book, film, and word lists.

The reading level has been kept well within the capabilities of most children of these grades who will also find the illustrations and projects easy to understand and follow.

As basic science texts with additional references, or as supplementary volumes to some other science text, this series will contribute strongly toward the development of a successful elementary school science program.

SEYMOUR TRIEGER
Herricks Junior High School
New Hyde Park, New York

Audio-Visual REVIEWS

INTERIM REPORT. 15 min. sound, 1955. B & W, loan without cost. Division of Public Education, National Foundation For Infantile Paralysis, 120 Broadway, New York 5, N. Y.

Recommendation: Junior and senior high school and adult levels.

Content: The history of the fight against polio demonstrates how the American people conquer disease through organization and volunteer service. Highlights of the film range from Michael Underwood's first description of polio in 1789 to the development and use of the Salk vaccine.

Evaluation: A timely film of deep interest to all, with good commentary and very good description, photography, and content. A teacher's guide comes with the film.

◇ ◇ ◇

BROWN BEARS GO FISHING. 11 min. sound, 1955. $55 B & W, $100 Color. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Recommendation: Lower elementary grades in science, social studies, and language arts areas.

Content: Depicting Alaskan brown bears in their natural habitat, the film shows them as they eat, swim, fish, and care for their young. Overprints and repetition in the narration will help children develop the vocabulary they will use in reading and telling stories about bears. The film also includes several sequences about other popular storybook bears, the polar and grizzly bears.

Evaluation: An excellent film in all respects; the color photography is good. In stressing the natural environment, the film presents a true picture of the animal's way of life which the children will understand and appreciate. A teacher's manual is available.

◇ ◇ ◇

THE CLOTHES WE WEAR, PLANTS MAKE FOOD, and PIPES IN THE HOUSE. Each: 11 min. sound, 1954. $50 B & W, $100 Color. Churchill-Wexler Film Productions, 801 Seward St., Los Angeles 38, Calif.

Recommendation: Intermediate grade levels in the science, health, and social studies areas.

Content: In THE CLOTHES WE WEAR, Craig and Toni find out why clothing keeps them warm. The film discusses animal, plant, and synthetic fibers; contrasts primitive methods of spinning thread and weaving cloth with modern methods; and develops an appreciation of the abundance and value of the clothes we wear. In PLANTS MAKE FOOD, the two children learn something of the process by which plants make food; the functioning of roots, stems, and leaves; the transforming of water, minerals, and carbon dioxide into foods; and the role played by chlorophyll and sunlight. Through this film, which combines live action and animation, the children discover the importance of plants as the ultimate source of food. In PIPES IN THE HOUSE, the flow of water from reservoir into the house, the flow of gas from oil field into the home, and the flow of electricity within the house are traced for the children. The three films were made in collaboration with D. C. Heath and Co., publishers of the Heath Elementary Science Texts.

Evaluation: Excellent, well organized films.

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CRYSTAL GAZING. 12 min. sound, 1954. $45 B & W, $90 Color. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Senior high school chemistry and geology areas.

Content: The film colorfully portrays the beauty of natural crystals, such as those found in caves, and of underground formations, and the formation of crystal structure in many types of chemical substances. Showing the structure of crystals under polarized light, the film definitely stresses the formation of crystals with the aid of microscopes and microscopic examination.

Evaluation: A fine film with general excellence for color photography. The special emphasis on the technical quality of the material presented is noteworthy. Excellent use of microscopic analysis is particularly effective in bringing out the interesting pattern structure of crystals. A teacher's manual is included.

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CONQUEST OF PAIN. 20 min. sound. B & W. Teaching Film Custodians, 25 West 43rd St., New York 36, N. Y.

Recommendation: Senior high school and adult level.

Content: Telling the story of the first use of ether in the mid-19th century, the film presents the experiences and experiments of the anesthetic's discoverer, W. T. G. Morton, a Boston dentist.

Evaluation: A fine film, presenting one of medical history's great moments and stressing the importance of experimentation and research in man's conquest of pain. Following historical fact closely, the film should stimulate discussion as to Morton's place in civilization. A teacher's guide is available.

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SEA SHELL ANIMALS. 10 min. sound, 1955. $50 B & W, $100 Color. Film Associates, 10521 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Science and nature study areas, from 5th grade through junior high school.

Content: Photographed at the Marineland of the Pacific, the film describes shells and animals whose homes are in shells, including sea shore shelled animals, chiton, sea mussels, clams, limpet, abalone, wavy top, cowrie, and

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octopus. The film indicates how collecting and identifying shells can be an interesting hobby.

Evaluation: An excellent film in which the commentary adds definite value and interest to the content. In color, the photography has exceptional clarity.

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GREAT NAMES IN BIOLOGY. 50-frame filmstrip series, 6 titles, 1955. Series $36, each $6. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: 9th grade general science and accelerated groups and senior high school science areas.

Content: The dramatic lives of six of the most famous men in the field of biological science are graphically retold in these filmstrips by means of vivid color drawings and carefully worded captions. The scientists presented are: Louis Pasteur, developer of the germ theory of infection; Gregor Mendel, first discoverer of the law of heredity; Charles Darwin, father of the theory of evolution; William Harvey, discoverer of blood circulation; Carolus Linnaeus, designer of a plant classification system; and Antony van Leeuwenhoek, discoverer of the world of microscopic life.

Evaluation: Instructional qualities rated excellent, and good for building attitudes and science appreciation. The use of caricature makes for effective presentation of the highlights in the life of each scientist. A teacher's guide is included.

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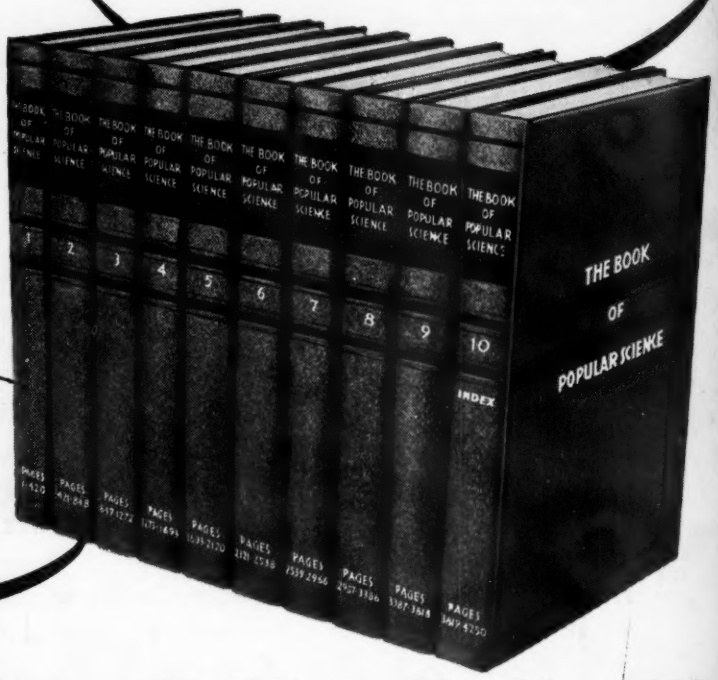

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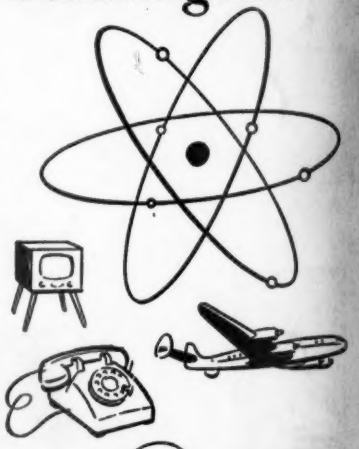

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